Conversations in Human Evolution

Volume 1

Edited by
Lucy Timbrell

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Conversations in Human Evolution

Lucy Timbrell[1]

Introduction:

Conversations in Human Evolution (https://conversationsinhumanevolution.wordpress.com) is a science communication project exploring the breadth and interdisciplinarity of human evolution research at a global scale. Through informal but informative interviews (henceforth referred to as 'conversations'), this project delves deeply into topics concerning the study of our species' evolutionary lineage, covering the current advances in research, theory and methods as well as the socio-political issues rife within academia. This project also provides important insights into the history of human evolutionary studies. This volume is the result of the first twenty conversations, published online between March and June 2020. When this volume went to press, this subset of the conversations had been collectively viewed 6817 times since they were made available on the website.

The idea for Conversations in Human Evolution (CHE) arose in March 2020 during the escalation of the COVID-19 global pandemic. Following the cancellation and postponement of in-person events, CHE became a creative project to encourage engagement with human evolutionary research during this time of isolation and confinement. It was noticed that, whilst there is great public interest in this area of research, there are few freely accessible online resources about human evolutionary studies itself (though see https://humanorigins.si.edu/ for a good example of a publicly available resource). What's more, science engagement initiatives are almost always concerned with communicating exciting results and discoveries, and whilst this is obviously the most important aspect of science communication, it can lead to the neglection of the personal experiences of the scholars behind the science. Broader socio-political issues within subject-specific academic circles are also rarely discussed through publicly accessible communicative forums, somewhat depersonalising the science and perhaps even romanticising academia in certain ways. CHE fills this void by asking - what does it actually mean to study and research human evolution in the 21st century?

Human evolution studies, by definition, is a discipline concerned with the deep past. We explore the most pertinent questions about the evolution of humanity, such as the emergence of complex language and culture. The exploration of such issues allows researchers to look back into our species' evolutionary history to better understand our present and our future. Yet, we rarely consider the role of history and personal experience in the shaping of human evolution research. Acknowledging that the history of our discipline and its historical figures deserve focus in their own right is a fundamental premise of CHE as, in the same way that human evolutionary research drives our understanding of our past, present and future selves, historical and personal contexts have driven modern approaches to the deep past. CHE bridges the gap between the research and the researcher, contextualising modern science with personal experience and historical reflection.

Themes:

The conversations featured in this volume can be organised into five non mutually exclusive categories based on research interests: (1) quaternary and archaeological science, (2) Palaeolithic archaeology, (3) biological anthropology and palaeoanthropology, (4) primatology and evolutionary anthropology, and (5) evolutionary genetics. CHE features scholars at various different stages in their careers and from all over the world; in this volume, researchers are based at institutions in seven different countries

[1] Department of Archaeology, Classics and Egyptology, University of Liverpool, U.K.; lucyjt@liverpool.ac.uk

(namely the United Kingdom, Australia, the United States of America, Germany, Denmark, India and China), covering four continents.

The first section of this volume features five conversations with quaternary and archaeological scientists, covering topics such as quantitative methods in archaeology, human-environment interactions, palaeoecology and geoarchaeology. In this section, Dr Enrico Crema first discusses his research into evolutionary cultural change and prehistoric demography, with a particular focus on Japanese prehistory, as well as the importance of being a 'π-shaped' researcher with domain-specific knowledge and analytical and computing skills (Marwick, 2017). Professor Felix Riede builds on this idea, suggesting that 'π-shaped' researchers should learn how to 'hold hands' and work collaboratively. He also discusses previous and current projects attempting to understand how paleoclimates have interacted with past societies, and the role that archaeology can play in current discourse in contemporary climate change (Hussain and Riede, 2020). Professor Ben Marwick details the importance of 'open access archaeology' as well as some of his many projects in Southeast Asia. Quaternary Scientist, Professor Chris Hunt recounts his work at the ongoing Shanidar Cave Project in Iraqi Kurdistan (among his many other projects), which has recently published fascinating results on Neanderthal mortuary practises (Pomeroy et al., 2020). Professor Andy Herries also reviews his recent publications, such as the dating of the DNH 134 *Homo erectus* fossil (Herries *et al*., 2020). As well as discussion about his ongoing work in geoarchaeology and geochronology, he stresses the importance of working with local collaborators and communities.

The second section features five conversations with Palaeolithic archaeologists working all over the world. This section highlights the ongoing global research that is being carried out to further understand prehistoric human behaviour over a huge geographic area. Starting in Asia, Professor Shanti Pappu recounts her experiences of researching the Indian Palaeolithic, drawing special attention to the importance of her outreach programmes with local schools during excavation. Professor Michael Petraglia details his interdisciplinary work in South Asia and East Asia – as well as Arabia and eastern Africa – which has the overarching focus of understanding the origin and dispersal of our own species. Dr Shi-Xia Yang describes her recent work on the stone tools of Palaeolithic in East Asia, making links between hominin behaviours and climatic change in the region. Moving into African Stone Age archaeology, Professor John Gowlett explores his experiences working in eastern Africa (see Cole *et al*., 2020 for a festschrift dedicated to John's career), illustrated with amazing pictures from his personal archive. Professor Eleanor Scerri next describes her ongoing work in northern and western Africa. Like others in this volume, she encourages the development of new quantitative and computational methods for interpreting patterns in the archaeological record. Finally, coming into the European Palaeolithic, Dr Rob Davies describes his work at the British Museum looking at the archaeology of ancient Great Britain. As a mature student coming into archaeological research later in life, he provides an invaluable account of his experiences within academia.

Four biological anthropologists and paleoanthropologists are featured in the third section. This section covers topics such as evolutionary medicine, comparative anatomy and the significance of new fossil discoveries. Dr Emma Pomeroy first describes some of her latest work in evolutionary medicine on the osteological indicators of body fatness (Pomeroy *et al*., 2018), discussing the implications of this work on modern health. She also sheds further light on the Neanderthal remains from excavation of Shanidar Cave. Professor Chris Stringer talks us through his expansive career in physical anthropology, including his PhD at the University of Bristol which led to the establishment of the Out of Africa hypothesis (Stringer and Andrews, 1988). Professor Katerina Harvati describes some of her most recent research at Apidima Cave on some of the oldest *Homo sapiens* fossils outside of Africa (Harvati *et al.,* 2019). She goes on to discuss some of the technological and methodological advancements that have revolutionized modern anthropological science as well as some of academia's socio-political issues that still require attention, like the representation of women and ethnic minorities in human evolution research as well

as sexual harassment. Finally, Professor Bernard Wood recounts his experiences working with Richard Leakey and other well-known paleoanthropologists during the 'golden era' of fossil discoveries.

The fourth section includes three interviews from researchers working within primatology and evolutionary anthropology. First, Professor Susana Carvalho describes how she helped to establish the field of 'primate archaeology' (Haslam *et al*., 2009). She also outlines the progression of the Gorongosa Field School and Palaeo-Primate Project in Mozambique which she directs. Like many others, she also strongly advocates the training of local students to lead research in these areas. Then, Dr Isabelle Winder, a self-proclaimed 'question-led researcher', discusses the broad nature of her past and present projects, including some very interesting work in the modelling of non-primate species distributions in response to climate change (Hill and Winder, 2019). Finally, Professor Fiona Jordan discusses her work on the VariKin project which uses data, methods and theory from anthropology, biology, linguistics and psychology to explore kinship system diversity. Interestingly, in this conversation, she reflects on her experiences working in academic institutions all over the world and discusses some of the national differences that she has found.

Last, the final section focuses on individuals working on evolutionary genetics as it features conversations with two population geneticists. First, Professor Eske Willerslev discusses the significance of environmental DNA (Willerslev *et al*., 2003) for understanding biological activity in the past, a field within evolutionary genetics that he founded. He also discusses some of his biggest achievements, such as the first whole-genome sequencing of an ancient human genome (Rasmussen *et al.*, 2010), and proposes some of the most promising avenues of future research for human evolution studies, such as proteomics. Second, Dr Pontus Skoglund addresses the interaction between archaeology and genetics, discussing some of the contentious issues between the two, such as the definition of ancestry. He also describes his research into the links between population migrations and the global transition to agriculture, archaic gene flow, early human evolution in Africa and more.

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I would like to first thank Dr Matt Grove and Dr Kimberly Plomp, for reading initial drafts of this volume. I would also like to thank all of those who have contributed to Conversations in Human Evolution and have taken part in and supported the project so far. I would also like to acknowledge the Arts and Humanities Research Council for their ongoing support. Finally, many thanks to my sister, Holly Timbrell, for designing the Conversations in Human Evolution logo.

References:

Cole, J., McNabb, J., Grove, M., and Hosfield, R. (Eds.). (2020). *Landscapes of Human Evolution: Contributions in Honour of John Gowlett*. Summertown, Oxford: Archaeopress. doi:10.2307/j.ctvx5w983

Harvati, K., Röding, C., Bosman, A. M., Karakostis, F. A., Grün, R., Stringer, C., Karkanas, P., Thompson, N. C., Koutoulidis, V., Moulopoulos, L. A., Gorgoulis, V. G., and Kouloukoussa, M. (2019). Apidima Cave fossils provide earliest evidence of *Homo sapiens* in Eurasia. *Nature*, 571(7766), pp. 500-504. doi: 10.1038/s41586-019-1376-z

Haslam, M., Hernandez-Aguilar, A., Ling, V. Carvalho, S., de la Torre, I., DeStefano, A., Du, A., Hardy, B., Harris, J., Marchant, L., Matsuzawa, T., McGrew, W., Mercader, J., Mora, R., Petraglia, M., Roche, H., Visalberghi, E. and Warren, R. (2009). Primate archaeology. *Nature,* 460, pp. 339–344. DOI: 10.1038/nature08188.

Herries, A. I. R., Martin, J. M., Leece, A. B., Adams, J. W., Boschian, G., Joannes-Boyau, R., Edwards, T. R., Mallett, T., Massey, J., Murszewski, A., Neubauer, S., Pickering, R., Strait, D. S., Armstrong, B. J., Baker, S., Caruana, M. V., Deham, T., Hellstrom, J., Moggi-Cecchi, J., Mokobane, S., Penzo-Kajewski, P., Rovinsky, D. S., Schwartz, G. T., Stammers, R. C., Wilson, C., Woodhead, J. and Menter, C. (2020). Contemporaneity of *Australopithecus*, *Paranthropus*, and early *Homo erectus* in South Africa. *Science*, 368(6486). DOI: 10.1126/science.aaw7293.

Hill, S. E. and Winder, I. C. (2019). Predicting the impacts of climate change on *Papio baboon* biogeography: Are widespread, generalist primates 'safe'?. *Journal of Biogeography*, 46, pp. 1380– 1405. DOI: 10.1111/jbi.13582.

Hussain, S. T. and Riede, F. (2010). Paleoenvironmental humanities: Challenges and prospects of writing deep environmental histories. *WIRES Climate Change*, 11(5), pp. 1-18. DOI: 10.1002/wcc.667.

Marwick, B. (2017). Computational reproducibility in archaeological research: Basic principles and a case study of their implementation. *Journal of Archaeological Method and Theory*, 24(2), pp. 424-450. DOI: 10.1007/s10816-015-9272-9.

Pomeroy, E., Bennett, P., Hunt, C. O. Reynolds, T., Farr, L., Frouin, M., Holman, J., Lane, R., French, C., and Barker, G. (2020). New Neanderthal remains associated with the 'flower burial' at Shanidar Cave. *Antiquity*, 94(373), pp. 11-26. DOI: 10.15184/aqy.2019.207.

Rasmussen, M., Li, Y., Lindgreen, S., Pedersen, J. S., Albrechtsen, A., Moltke, I., Metspalu, M., Metspalu, E., Kivisild, T., Gupta, R., Bartalan, M., Nielsen, K., Gilbert, M. T. P., Wang, Y., Raghavan, M., Campos, P. F., Kamp, H. M., Wilson, A. S., Gledhill, A., Tridico, S., Bunce, M., Lorenzen, E. D., Binladen, J., Guo, X., Zhao, J., Zhang, J., Li, Z., Chen, M., Orlando, L., Kristiansen, K., Bak, M., Tommerup N., Bendixen, C., Pierre, T. L., Gronnow, B., Meldgaard, M., Andreasen, C., Fedorova, S. A., Osipova, L. P., Higham, T. F. G., Ramsey, C. B., Hansen, T. V. O., Nielsen, F. C., Crawford, M. H., Brunak, S., Sicheritz-Ponten, T., Villems, R., Nielsen, R., Krogh, A., Wang, J. and Willerslev, E. (2010). Ancient human genome sequence of an extinct Palaeo-Eskimo. *Nature,* 463, pp. 757–762. DOI: 10.1038/nature08835.

Stringer, C. and Andrews, P. (1988). Genetic and fossil evidence for the origin of modern humans. *Science*, 239(4845)1, pp. 263–1268. DOI: 10.1126/science.3125610.

Willerslev, E., Hansen, A. J., Binladen, J., Brand, T. B., Gilbert, T. P., Shapiro, B., Bunce, M., Wiuf, C., Gilichinsky, D. A. and Cooper, A. (2003). Diverse Plant and Animal Genetic Records from Holocene and Pleistocene Sediments. *Science*, 300(5620), pp. 791–795. DOI: 10.1126/science.1084114.

Part 1: Quaternary and Archaeological Science

Dr Enrico Crema[2]

Dr Enrico Crema is a computational evolutionary archaeologist. He is currently based at the Department of Archaeology, University of Cambridge, where he holds the position of Lecturer in Computational Analysis of Long-Term Human Cultural and Biological Dynamics. His research covers a number of topics within archaeology, such as cultural evolution and transmission, Japanese prehistory and prehistoric demographic reconstructions. His research focuses on the use and development of computational and quantitative methods with a particular focus on agent-based simulations and spatial statistics. He has also developed a number of R packages, such as the rcarbon package (Crema and Bevan, 2020) which enables the calibration and analysis of radiocarbon dates for archaeological research.

What are your research interests and your particular area of expertise?

My (current) research themes are the study of cultural change as the result of an evolutionary process, its interplay with demography, and the application and the development of computational and statistical methods in archaeology and evolutionary anthropology.

What originally drew you towards human evolution studies?

I was very interested in palaeontology as a kid (yes dinosaurs!) and it was a hard choice to decide between an undergraduate degree in biology or in history/archaeology. I eventually chose the latter and initially thought I've completely shut down any possibility to study biological evolution. A few years later during my masters at UCL, I sat on a module in Evolutionary Archaeology taught by Ethan Cochrane and Stephen Shennan. The realisation that I can be an archaeologist, but at the same time have an evolutionary perspective to study human behaviour and cultural change blew my mind, so during the first year of my PhD I sneaked into as many undergraduate and graduate courses in biology and biological anthropology to catch up.

What was your PhD topic? How did you choose this and who was your supervisor?

My PhD (at UCL Institute of Archaeology) looked into settlement dynamics among the Jomon hunter-gatherers in Japan. I was particularly interested in long-term fluctuations between nucleated and dispersed settlement patterns (after I spent a year in Japan as an exchange student during my undergraduate degree), so I developed a simulation model of group fission-fusion dynamics (extending some earlier ideas from human behavioural ecology; Crema, 2014), and came up with some new way of analysing settlement data, inspired by how chronological uncertainty is handled in crime science (Crema, 2013)! I was very lucky to be supervised jointly by Andrew Bevan and Mark Lake on this - both were terrific mentors, and they profoundly shaped the way I approach research and teaching. I was also

[2] Department of Archaeology, University of Cambridge, UK; erc62@cam.ac.uk

one of the last students joining the AHRC Centre for the Evolution of Cultural Diversity; there I met other students and post-docs that are now at the forefront of Cultural Evolutionary Studies around the world.

After your PhD, what positions have you held and where?

I was hired as a post-doc for Stephen Shennan's EUROEVOL Project right after my viva (I did a Skype interview in the middle of the night while visiting the States for a talk). This was a great opportunity for me to dive into evolutionary archaeology with the support of an amazing team of colleagues. I particularly enjoyed weekly meetings with Stephen where he would suggest some obscure (to me) paper from another field, chatting about how some concepts can be adapted to study of cultural change. I then did an MSCA-IF at the Pompeu Fabra University in Spain with the CaSES research group led by Marco Madella (another great mentor!) and was involved in his 'Simulpast', a large collaborative project which focused on the theory and method of simulation studies in archaeology. I then came to Cambridge as a McDonald Fellow in 2016; I was supposed to work on a project on the emergence and evolution of cultural boundaries, but a few months later I accepted a lectureship that I am currently holding.

What current projects are you working on at the University of Cambridge?

I'm currently working on two projects. The first one is the Leverhulme-funded 'Crops, pollinators and people: the long-term dynamics of a critical symbiosis (Buckbee)' project led by Prof. Martin Jones, with the collaboration with Prof. Richard Evershed (University of Bristol). We are looking at the origin and spread of insect-pollinated crops (buckwheat) using different approaches (e.g. DNA, organic residue analyses, etc.). I am working with my PhD Student, Marta Krzyzanska, who is doing some cool Bayesian analyses to model the ecological niches of Buckwheat.

The second project is an ERC-starter grant I'm directing called 'Demography, Cultural change, and the Diffusion of Rice and Millet during the Jomon-Yayoi transition in prehistoric Japan (ENCOUNTER)'. The project looks at the demic and cultural diffusion event that started about 3,000 years ago in the Japanese archipelago and brought a package of cultural and economic practices from mainland Asia.
We are particularly focusing on how and why different regions reacted to this event, as we have evidence suggesting that some accepted the new practices immediately, while others resisted for several centuries, chose only specific cultural traits, or even reverted to previous practices after an initial uptake. We are also developing a series of bespoke methods for this project, and some are already giving us some new insights on prehistoric Japan. We just published a paper where we introduced a new approach for reconstructing prehistoric population dynamics and applied this to a case study from the Jomon period (Crema and Kobayashi, 2020). The results showed that the timing of a major demographic event was 500 years earlier than we previously thought, questioning some of the climate-led hypothesis that suggested so far.

Why is your research important for understanding prehistoric human behaviour?

I think cultural evolutionary theory has still lots to offer in archaeological research. Many of the early works have focused macroevolution and there have been some attempts also to look at high-quality data from a microevolutionary perspective, reconstruing for example modes of transmission from frequency data (Crema *et al*., 2016). But I think there has been less work between these two levels - in particular the study of horizontal transmission *between* populations. This is a tricky scale, but an exciting one that can help linking micro to macroevolution, and I hope the ENCOUNTER project can give us some new insights.

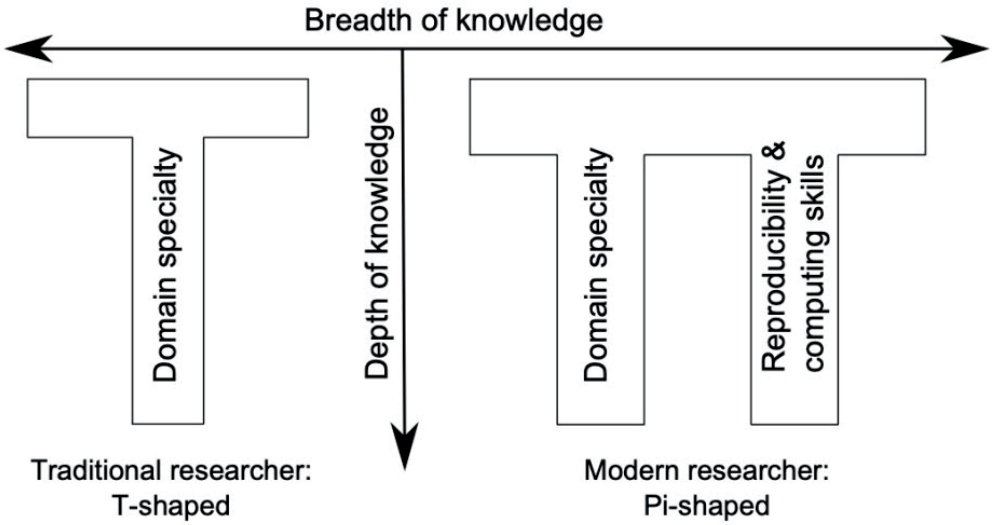
Enrico delivering a talk on the 'Diversity of Jomon life-ways' in the East Asia Seminar Series at the University of Cambridge (2017). Photo by Freddie Semple.

What project or publication are you most proud of?

That's a tough question! I usually feel everything is a work in progress and start to see more and more flaws after papers get published! There is one paper I particularly enjoyed writing that was published few years ago on Human Biology though; it has an awful title ('Cultural Incubators and Spread of Innovation'), but Mark Lake and I found some interesting dynamics on how adding uncertainty in payoff-biased transmission can be detrimental in larger interconnected groups (Crema and Lake, 2015).

What advice would you give to a student interested in your field of research?

When I was at high school, I hated math and computer science - now I teach both regularly and enjoy coding. I think many fields are rapidly changing in this regard, and computing, quantitative skills, and open science are now becoming the norm. Ben Marwick wrote a great paper a few years ago where he argues for a shift from T-shaped researchers with an in-depth in knowledge in a particular domain to Pi-shaped researchers with in-depth knowledge in a particular domain *and* an in-depth knowledge in computing skills (Marwick, 2017). So, my advice is to be patient and learn those skills. Math and coding are like languages - you cannot enjoy learning one by just reading a book of grammar rules. But if you find the right content (mine was learning about spatial archaeology and cultural evolutionary theory) these skills will not be just useful but also enjoyable.



T-shaped and Pi-shaped researchers. Reprinted from Marwick (2017).

References:

Crema, E. R., Bevan, A. (2020). Inference from large sets of radiocarbon dates: software and methods. *Radiocarbon,* pp. 1-17. DOI:10.1017/RDC.2020.95.

Crema, E. (2013). Cycles of change in Jomon settlement: A case study from eastern Tokyo Bay. *Antiquity, 87*(338), pp. 1169-1181. DOI: 10.1017/S0003598X00049930.

Crema, E.R. (2014). A Simulation Model of Fission–Fusion Dynamics and Long-Term Settlement Change. *Journal of Archaeological Method and Theory,* 21, pp. 385–404. DOI: 10.1007/s10816-013-9185-4.

Crema, E., Kandler, A. and Shennan, S. (2016). Revealing patterns of cultural transmission from frequency data: equilibrium and non-equilibrium assumptions. *Scientific Reports,* 6, pp. 39122. DOI: 10.1038/srep39122.

Crema, E. R. and Kobayashi, K. (2020). A multi-proxy inference of Jōmon population dynamics using bayesian phase models, residential data, and summed probability distribution of 14C dates. *Journal of Archaeological Science,* 117, pp. 105136. DOI:10.1016/j.jas.2020.105136.

Crema, E. and Lake, M. (2015). Cultural Incubators and Spread of Innovation. *Human Biology, 87*(3), pp. 151-168. DOI:10.13110/humanbiology.87.3.0151.

Professor Felix Riede[3]

Professor Felix Riede is a climate change archaeologist based at Aarhus University. His research concerns the shifting interactions between humans and their environment, exploring how environmental changes have impacted past human societies as well as how humans have impacted the environment. At Aarhus University, Felix leads the Laboratory for Past Disaster Science, which focuses on cultural transmission and climatic resilience within prehistoric European populations, as well as an ERC-funded project 'CLIOARCH' (https://cas.au.dk/en/ERC-clioarch/), which is developing computational approaches to Final Palaeolithic/earliest Mesolithic archaeology and climate change.

What are your research interests and your particular area of expertise?

My research has two main trajectories. On the one hand, I try to understand how past climates and environments have interacted with past humans and, on the other, what role archaeology plays in contemporary climate change. All of this is bound together by an underlying evolutionary framework that sees culture as the product of evolutionary processes and that sees humans as sometimes subtle, sometimes powerful, niche constructors (the so-called Extended Evolutionary Synthesis or EES approach).

What originally drew you towards human evolution studies?

This is a great question! I was born and raised in Germany where at that time you had to pick four subjects for your final school-leaving exams. I chose Latin, English, History and Biology. My school background is really very much in the Classics – I took Latin, Ancient Greek as well as, for my sins, also Ancient Hebrew – but got entirely hooked on the Palaeolithic and on palaeoanthropology during my first few weeks as a bushy-tailed Joint Honours Arch and Anth BA student in Durham. So, while I was never, somehow, really in doubt about pursuing a career in archaeology, I found myself surprised by just how fascinated I became with our earliest prehistory. But then again, it did allow me to in fact continue the blend of interests that I had already hit upon in my last years at school!

The interesting thing is that I then quite early on in my studies also came across the EES or, as it then was known, niche construction theory. This has really stuck and provided an Ariadne's thread throughout most of my career.

[3] Department of Archaeology, Aarhus University, Denmark; f.riede@cas.au.dk

What was your PhD topic? How did you choose this and who was your supervisor?

I took my PhD at Cambridge, dabbling in archaeogenetics, and looking at the human re-colonisation of Northern Europe at the end of the Pleistocene. Peter Forster was my supervisor in the lab – and it was really instructive to experience bench science – and Preston Miracle my supervisor in all things archaeological. As much of my work goes across the biological and environmental sciences, and as I draw a lot on North American approaches in terms of theory and methods, this was a fairly good combination. Guided by niche construction theory, I used genetic, palaeoenvironmental and archaeological data in parallel to juxtapose these three foundational domains of change and inheritance. The attempt to really bring these data into sync failed, I think, but tons of interesting new insights arose, nonetheless. I did find a neat method to study niche construction archaeologically using quantitative comparative approaches (Riede, 2011) and, most productively of all, discovered the presumably causal connection between the Laacher See volcanic eruption some 13,000 years ago and cultural change in southern Scandinavia (Riede, 2008). That discovery – made in triangulation between volcanological insights, models of cultural evolution and the data I had collected – has since stayed with me and has given rise to follow-up projects that are keeping me busy even today. What more can you ask from a PhD thesis?

After your PhD, what positions have you held and where?

The week after I handed in my thesis, I took up a non-stipendiary Junior Research Fellowship in Cambridge – all glory, no money – and also served as Faculty Teaching Assistant on the old Cambridge Tripos. Rob Foley at the then shiny new Leverhulme Centre for Human Evolutionary Studies kindly took me in and gave me an office, which I shared with like-minded graduate Stephen Lycett. I was desperately writing up my papers and applying for jobs and fellowships. After getting close at both UCL and Durham, I landed a British Academy Postdoctoral Fellowship – that was amazing! After a final post-PhD year in Cambridge then, I began this new role, which took me to Stephen Shennan's AHRC-funded Centre for the Evolution of Cultural Diversity at UCL. And while commuting was hard, this was an intellectual home coming. It really was a hive of cultural evolutionary thinking with a lively journal club, superb seminars and conferences. A great bunch of bright minds were there at the time, for instance, Fiona Jordan (this vol.) and Enrico Crema (this vol.) whom you've also interviewed but many more. Besides the intellectual atmosphere, it was also the first time I really experienced the power of team science in archaeology – and that has really stuck with me as well.

In late 2008, merely a year and a bit into my three-year fellowship, I got offered, to my honest surprise, a tenure-track Assistant Professorship at Aarhus University. There was a lot of 'right time, right place' to this appointment, but it was just perfect. My wife is half-Danish and I do focus on this region in much of my research. Thanks to an extended data collection stay in Denmark during my PhD – and my persistence – I also spoke some Danish. The department there was going through a critical generational change at that time and my appointment was part of this process. Over the ten-plus years I have now been here – with sabbatical stints at Cambridge, MA (Harvard Anthropology) and at Cambridge, UK (Geography) – I have been fortunate enough to witness, contribute to and partly shape that development. We're now an international and diverse Department of Archaeology and Heritage Studies, rank well globally, and have active research in an exciting variety of fields – not least the Palaeolithic. Since 2019, I also hold a secondary affiliation with the Oslo School of Environmental Humanities where I'm working actively to bring more deep-time perspectives to our new understanding of human-environment relations. We call it the 'Palaeoenvironmental Humanities' and recently published a sort of manifesto for it (Hussain and Riede 2020).

What current projects are you working on?

I'm an ideas person, so I'm involved in a bunch of awesome projects at any one time and definitely also now. Some projects are big, others small. I get excited about all of them. For some years now and almost without interruption, I've had funding from the Independent Research Fund Denmark to pursue this hypothesis about the Laacher See eruption and its human impact. My current project on this called "Apocalypse then? The Laacher See volcanic eruption (13,000 years before present), Deep Environmental History and Europe's geo-cultural heritage" not only seeks to better understand the ecological and cultural relations at this time but to use the isochron of the ash fallout to think hard about what may have made Final Palaeolithic societies resilient or not to such sudden impacts. The project is its final phase and we'll end on a special exhibition at the amazing Moesgård Museum here in Aarhus and an edited volume to be published with Berghahn Press (Riede and Sheets, 2020). What we're trying with both the exhibition and the edited volume is to translate some of our scientific insights into public debate and actionable insights with regard to future vulnerability. The COVID-19 crisis really highlights just how poorly also European society actually is prepared for major shocks and even mild prognoses of future environmental change foresee many more extreme events. The archaeological record of the deep past can, we argue, be used to help prepare for these.

The other main project I direct at the moment is called CLIOARCH. It's funded by an ERC Consolidator Grant and really is a dream project that combines my interest in cultural evolution, classification, computational archaeology and environmental archaeology to address some major outstanding issues in the Late Palaeolithic of Europe. You can read a crash summary of the project in *Antiquity*'s Project Gallery (Riede et al., 2020). The generous funds from the ERC have allowed me to put together a great team and we're having a blast doing really good science. It's still early days in that project, but major papers addressing foundational conceptual (Ivanovaite *et al*., 2019) and research historical (Reynolds and Riede, 2019) issues have already appeared.

Beyond those, I'm also involved in some more applied work, where we provide a climate-historical perspective as part of the large EU-funded project Coast to Coast Climate Challenge (https://www.c2ccc.eu/english/). Based on the insight that narrative is an effective way of discussing and debating climate issues and of stimulating action, we present coupled climate-culture stories from Central Jutland's past. I'm also involved with some nifty Neanderthal work spearheaded by my former PhD student Trine Nielsen. Starting whenever COVID-19 allows, that project will look further into the northern range expansions and contractions of Neanderthals and what these can tell us about their adaptive envelopes. I'm so excited to be part of this project because Neanderthals are really what got me properly hooked on the Palaeolithic in the first place and because the project's PI Trine was my first PhD student – she's now becoming a PI in her own right and that makes me quite so proud.

But there are more projects still, on prehistoric play objects and how they feature in cultural evolution (Nowell et al., 2020), on culture change in Arctic Norway (Jørgensen and Riede, 2019), on individual material culture signatures in the Hamburgian culture (Riede and Pedersen, 2018), on Anthropocene archaeology (Riede *et al*., 2016a), and not least on early cognitive evolution (Tylen *et al*., 2020) – I'm excited about all of them, but let's leave these for another time.

A silly photo of an eager young Felix sorting animal bone fragment at the post-ex station at Sibudu Cave in KwaZulu-Natal (South Africa), one of the many amazing sites Palaeolithic archaeology can take you. The other person in the picture is the formidable and fun Manda Maples, now curator of African art at the North Carolina Museum of Art.

Why is your research important for understanding prehistoric human behaviour?

I seek to combine to combine an attention to theory (especially epistemology and systematics) and research history with solid empirical work. I do think that Palaeolithic archaeology needs theory – cultural evolutionary theory – and properly, logically consistent systematics. I also believe that much of the method development we're engaged in at the moment, exploring phylogenetic and comparative methods as well as distribution models, can lead to much wider applications and major insights.

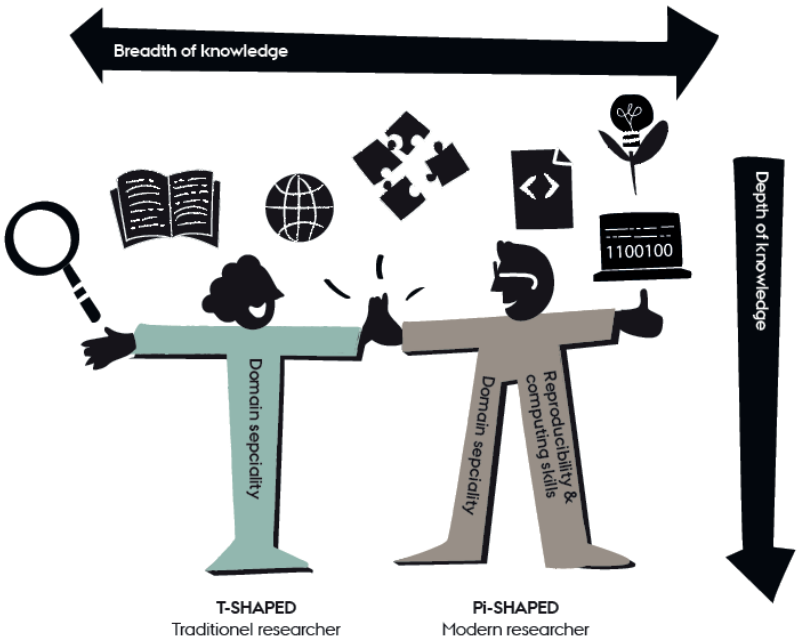
I also do believe that what we do isn't just important for understanding prehistoric human behaviour but also for understanding our present quandaries vis-à-vis climate and environmental change. There's a clear ethical dimension to what we do (Riede *et al*., 2016b).

What project or publication are you most proud of?

Eek, you're asking me to pick a favourite amongst my little darlings! In terms of sheer effort, it's got to be my monograph (Riede, 2017) – but I'm not sure this is the text I most enjoyed writing.

What advice would you give to a student interested in your field of research?

In thinking about this question, I read Enrico Crema's excellent answer (Crema, this vol). He recounted how he relatively late in his archaeological career discovered quantitative approaches and how he has learned to love them. I have had precisely the same experience – and beyond some important theoretical developments and of course the refinement of natural science techniques and field discoveries, I think the true frontier of archaeological research rests in quantitative, data-driven approaches; and I'm all in. But Enrico also referred to the difference between (domain-specialist) T- and (domain-specialist plus quantitatively enabled) π-shaped researchers. To this I would add that we really no longer can see researchers, of whatever shape, as individual units anymore and that all these T- and π-shaped folks now need to get much better at holding hands: at pooling their skills and do good archaeological team science. The world as such and archaeology as well have become so complex in data and methods that individuals no longer can do it alone anymore. So, my advice to students would be to take collaborative work seriously, try to join a research team, and to seek out a good mentor.



A cartoon of π-shaped researchers that boast both knowledge (K) breadth and depth as well as statistical acumen learning to 'hold hands' and do archaeological team science, also with colleagues of other shapes.

References:

Hussain, S.T., Riede, F. (2020). Paleoenvironmental humanities: Challenges and prospects of writing deep environmental histories. *WIREs Climate Change* ,11, pp. 667. DOI:10.1002/wcc.667.

Ivanovaitė, L., Serwatka, K., Hoggard, C., Sauer, F., and Riede, F. (2020). All these Fantastic Cultures? Research History and Regionalization in the Late Palaeolithic Tanged Point Cultures of Eastern Europe. *European Journal of Archaeology, 23*(2), pp. 162-185. DOI:10.1017/eaa.2019.59.

Jørgensen, E. K. and Riede, F. (2019). Convergent catastrophes and the termination of the Arctic Norwegian Stone Age: A multi-proxy assessment of the demographic and adaptive responses of mid-

Holocene collectors to biophysical forcing. *The Holocene*,2 9(11), pp. 1782-1800. DOI:10.1177/0959683619862036.

Nowell, A., Langley, M.C., Riede, F. (2020). Children and innovation: A Wenner-Gren workshop. *Evolutionary Anthropology: Issues, News, and Reviews*, 29, pp. 6–8. DOI:10.1002/evan.21816.

Reynolds, N. and Riede, F. (2019). House of cards: Cultural taxonomy and the study of the European Upper Palaeolithic. *Antiquity, 93*(371), pp. 1350-1358. DOI:10.15184/aqy.2019.49.

Riede, F. (2008). The Laacher See-eruption (12,920 BP) and material culture change at the end of the Allerød in Northern Europe. *Journal of Archaeological Science,* 35(3), pp. 591–599. DOI: 10.1016/j.jas.2007.05.007.

Riede, F. (2011). Adaptation and niche construction in human prehistory: a case study from the southern Scandinavian Late Glacial. *Philosophical Transactions of the Royal Society*. pp. *B*366793–808, DOI:10.1098/rstb.2010.0266.

Riede, F. (2017). *Splendid Isolation: The eruption of the Laacher See volcano and southern Scandinavian Late Glacial hunter-gatherers.* Aarhus University Press. ISBN 978 87 7124 127 3.

Riede, F., Andersen, P., and Price, N. (2016). Does environmental archaeology need an ethical promise?. *World Archaeology*, 48(4), pp. 466-481. DOI:10.1080/00438243.2016.1192483.

Riede, F., Hussain, S. T., Timmreck, C. and Svenning, J. C. (2020). CLIOdynamic ARCHaeology: computational approaches to Final Palaeolithic/Early Mesolithic archaeology and climate change. *Antiquity,* 94, pp. e13. DOI:10.15184/aqy.2020.85.

Riede, F. and Pedersen, J. B. (2018). Late Glacial Human Dispersals in Northern Europe and Disequilibrium Dynamics. *Human Ecology,* 46, pp. 621–632. DOI:10.1007/s10745-017-9964-8.

Riede, F. and Sheets, P. (2020). *Going Forward By Looking Back: Archaeological Perspectives on Socio-Ecological Crisis, Response and Collapse*. Berghan Press: Oxford. ISBN 978-1-78920-864-1.

Riede, F., Vestergaard, C., and Fredensborg, K. (2016). A field archaeological perspective on the Anthropocene. *Antiquity, 90*(354), pp. E7. DOI:10.15184/aqy.2016.18.

Tylén, K., Fusaroli, R., Rojo, S., Heimann, K., Fay, N., Johannsen, N. N., Riede, F. and Lombard, M. (2020). The evolution of early symbolic behavior in *Homo sapiens*. *Proceedings of the National Academy of Sciences*, 117(9), pp. 4578 LP – 4584. DOI 10.1073/pnas.1910880117.

Professor Ben Marwick[4]

Professor Ben Marwick is an archaeologist at the University of Washington. Ben's research interests are focussed within Southeast Asian and Australian archaeology, on topics such as hominin dispersals, forager technologies and ecology. He is also interested in how archaeology engages with local and online communities, in addition to popular culture, as well as techniques and methods for reproducible research and open science. Based in Seattle, Washington, he is locally affiliated with the eScience Institute, the Burke Museum, the Center for Statistics and Social Sciences, the Quaternary Research Center and the Southeast Asia Center. He has also been recently elected as a Vice President of the Society of Archaeological Sciences.

What are your research interests and your particular area of expertise?

I'm interested in the emergence of modern humans, specifically the dispersal of hominins into the Eastern hemisphere. I'm interested to understand how they adapted to new environments, and what their relationships were with other hominin groups and other species. My technical archaeological expertise is in stone artefacts and geoarchaeology. I also love to explore, analyze, and visualize any kind of archaeological data using the free and open source R programming language. I like to help others do their research with R also, because I think using open source code to do, and to communicate, scientific research is important for the sustainability of our field.

What originally drew you towards human evolution studies?

I am drawn towards studies of human evolution because of how it helps us understand our experience as humans, and how our cultures and societies came to be the way they are today. As a young kid I was interested in history, and the material traces of history. I spent a lot of time during school holidays working in remote sheep shearing sheds in the southwest of Western Australia. Probably a bit too much of that time was spent wondering about all the old rusty bits and pieces accumulated on the farm, and what life was like for people who used those antique tools. Later I was delighted to find out that researchers were analysing artefacts like these with chemistry, statistics, and so on, to understand past human behaviour. Then I knew I'd found the perfect combination of studying history, doing science, and working outdoors. I'm fascinated by scientific analysis of material culture as a way to learn about human behaviour and relationships in situations where we can't ask anyone directly. The unifying qualities of evolutionary theory are very inspiring to me, and the application of cultural transmission theory and behavioural ecological theory to understand changes in material culture appeals to my intuition. I think the understandings that come from studying material culture of the past are important for defining our individual and collective identities in the present, and how we identify ourselves is important for determining what we think is good, right and important, and how we behave to each other.

[4] Department of Archaeology, University of Washington, USA; bmarwick@uw.edu

Ben working at the Institute of Archaeology in Hanoi, Vietnam, with Prof. Lam My Dzung, Dr Pham Thanh Son, Dr Nguyen Doi and Eric Kelley.

What was your PhD topic?

The title of my PhD thesis is "Stone artefacts and human ecology at two rockshelters in Northwest Thailand" (data and R code are on Dataverse; Marwick, 2019). I studied stone artefacts and oxygen isotopes from shellfish to see how technology changed as climate changed. I found that technology didn't change much, but the way the landscape was used changed a lot. Although this is an arcane topic about a time and place that is exotic for most people, the results are immediately relevant to handling our contemporary problems relating to climate change and global warming. The message is that technological solutions don't need to play a major role in adapting to climate change, the big payoff is in changing human behaviours and routines.

Where did you complete your PhD and who was your supervisor?

I had a great time doing my PhD at the Department of Archaeology and Natural History at the Australian National University. My primary supervisor there was Professor Sue O'Connor, who was wonderfully supportive and a really inspiring role model. Professor Rasmi Shoocongdej generously allowed me to join her big project in northwest Thailand, and her support and encouragement has been vital to my success in archaeology. Professor Peter Hiscock was also my supervisor at the ANU, and he strongly influenced many of my views about archaeology and science generally.

Ben at Khao Toh Chong Rockshelter, Thailand, after excavations co-directed with Dr Cholawit Thongcharoenchaikit and staff from the Krabi Department of Culture.

After your PhD, what positions have you held and where?

I had the rare good luck to get a tenure-track job as an Assistant Professor at the University of Washington before I'd finished my PhD. My work there has been punctuated by some highly fulfilling fellowships, for example to spend time in Southern Thailand working with Rasmi and Cholawit Thongcharoenchaikit (thanks to ACLS/Luce), in Dublin with Helen Lewis, and in Tubingen with Chris Miller and the geoarchaeology group there (thanks to the DAAD). Most recently I was at the University of Wollongong as an Australian Research Council Future Fellow, working with the amazing group in the UOW Centre for Archaeological Science. Currently I'm back in Seattle working as an Associate Professor at the University of Washington.

Excavating on the Chauk Plateau, Myanmar, with co-director Kyaw Khaing and students from the Field School of Archaeology, Pyay.

What current projects are you working on?

Two current projects I'm especially excited about are with colleagues and community members in northern Vietnam with Pham Than Son, Mai Huong Ngyuen and colleagues at the Institute of Archaeology in Hanoi, and in Myanmar with Kyaw Khaing, Mae Su Ko and colleagues at the FIeld School of Archaeology at Pyay. We have a few locations under investigation that appear to preserve traces of early modern human activities in mainland Southeast Asia. Results from these projects will help us understand how people moved across the Eastern hemisphere, interacted with other hominin groups, and adapted to the unique conditions of this region. In these locations we are testing hypotheses from a model I proposed in 2009 to understand the ways that humans arrived in the region (Marwick, 2009).

To the north of these projects, I'm working on stone artefacts in southern China with Li Bo, Hu Yue and colleges that indicate prepared core and Levallois strategies (Hue et al., 2019). And to the south, I'm part of a big group led by Chris Clarkson and the Gundjeihmi Aboriginal Corporation, working on the analysis of materials we excavated from Madjedbebe, northern Australia, where people were living 65,000 years ago (Clarkson *et al.,* 2017).

Since COVID-19 brought lab and fieldwork to a halt early in 2020, I've been spending a bit more time on purely computational research, including reviving an interest I previously explored with Ian Kretzler. There have been some exciting recent developments in machine learning and text analysis that my lab group has been exploring and getting very interesting results with.

Where do you hope these go in the future?

In Vietnam and Myanmar we are excited to investigate some very promising locations with high-resolution excavation. We also are planning to combine this work with student training, in the form of undergraduate field schools, and local community participation, especially through local schools. We have grants from the Wenner-Gren Foundation and the National Geographic Society to support this work. For the Chinese and Australian projects we have some pretty substantial publications in preparation to advance the debate and respond to critics.

Ben giving a keynote address at the conference "Digital Heritage in a World of Big Data", Stirling, Scotland.

What is 'Open science' and why is it important in archaeology?

Open science is honouring the ideals of science that drew many of us to archaeology: transparency, reproducibility, objectivity, cooperation. As John Ziman put it, science 'is a cooperative enterprise, in which the enemy is ignorance, not the [person] in the other laboratory' (Ziman, 1981: 21). In practice, open science means access to scientific research that is unrestricted by financial, technical or cultural barriers. As for many sciences, the historical transition of archaeology from vocation to profession introduced incentives that have made it tough for researchers to adhere to these values. However, many fields have adopted innovative practices and technologies to revive and strengthen these values. Posting preprints of papers to enable free access to papers appearing in paywalled journals has been standard practice in Physics for over a decade. Since 2016 the *American Journal of Political Science* will only publish papers that are accompanied by raw data files and computer code files to reproduce the results presented in the manuscript (because when a paper says 'data are available from the corresponding author on reasonable request', that's often not true (Stodden *et al.,* 2018)) Over 5,000 journals and scholarly societies are signatories to the Transparency and Openness Protocol, as a pledge of their

support of the principles of openness, transparency, and reproducibility (including a handful of archaeology journals).

Getting our papers, data, and methods into the hands of as many of our colleagues as possible, as easily as possible, is not just an idealistic vision. It is vital for the long-term sustainability for archaeology as a discipline, because it supports the rapid and efficient accumulation and evaluation of new archaeological knowledge. Disciplines that are slow to realise this are going to increasingly balkanise and fade from relevance to the broader research community and society (and so struggle to attract funding and students). Among archaeologists, it has often been noted that resistance to transparency, openness and reproducibility sometimes comes from anxiety about perceived loss of status because of fear that sharing leads to a poverty of currency to trade in the traditional prestige economy of knowledge. To me, this resistance is part of the colonialist baggage of archaeology - knowledge and power practices that reproduce a logic of subordination. We now recognise it is necessary to reject these logics from our discipline. Open science is important for decolonising archaeology (Bruchac, 2014).

If we are serious about doing collaborative scientific work and producing results that are relevant to the communities we work with, we need to ensure they have access to our papers, data, and methods. This has a special urgency for human evolution researchers, because we are often working in parts of the world where our local colleagues lack many of the resources that researchers at Western institutions take for granted. Their university probably doesn't have a site license for ArcGIS, and their internet isn't fast enough to download a huge zip file from a dropbox. Many of our current 'good enough' practices for getting research done are not effective for properly including our collaborators. What do we need to change to ethically include our local collaborators in our research, and sustainably support the development of archaeological science and the study of human evolution in our host communities? Answering this question is a long term project, and will involve extra work for many of us. I reckon we can save a lot of time by adopting open science practices that have been already working well for other fields. Not all archaeological data are safe to share publicly (e.g. site locations, culturally sensitive images and objects), so doing open science thoughtfully requires consultation and planning to minimize risks of damage.

What project or publication are you most proud of?

I'm most proud of my publications that involve students, particularly undergraduates, and especially where we are part of a big team. That kind of work is more challenging and complicated than solo or small group work, but very fulfilling. Some of these include our paper on a 65 kya age for human activity in Australia (Clarkson *et al*., 2017), our paper on the transition from foraging to farming in Peninsula Thailand (Marwick *et al*., 2016), and our paper on replication assignments for teaching archaeological science (Marwick *et al*., 2019).

A distant second to these is my paper that Enrico Crema mentioned in his interview here, about computational reproducibility in archaeological science. That paper has enjoyed a wide readership far beyond archaeology, and led to many stimulating discussions and follow-up papers, for example with Suzanne Pilaar Birch (Marwick and Birch, 2018), Sophie Schmidt (Schmidt and Marwick, 2020), Li-Ying Wang (Marwick *et al*., 2020), and others. It's been very satisfying to see the influence of that paper on over one hundred archaeological journal articles so far, covering all kinds of topics and time periods, with authors making their data and R code available with their publication. This is vitally important for demonstrating the reproducibility of our research, to enable others to combine their data with previously published data, and for others to easily use newly published methods on their data.

Ben excavating at Madjebebe, Australia with the Gundjeihmi Aboriginal Corporation.

What advice would you give to a student interested in your field of research?

For a student interested in Southeast Asian Palaeolithic Archaeology my main advice is to aim for a sustainable balance between contributing to the international community of archaeologists (e.g. through scholarly communications at conferences and journal articles, etc.), and contributing to the local communities of students, researchers and community members that host your fieldwork (e.g. by visiting local schools, giving guest lectures and workshops at local universities, etc.). There are many challenges to overcome in achieving this balance, and it can be tough to find fulfilling ways to make useful contributions. One possible starting point would be to find something you like about archaeology, and work on incremental ways to make it even better.

More generally, for a student interested in archaeology and human evolution, my advice is to read widely and look for inspiration in related fields beyond archaeology, because "chance favours the connected mind". Connect not only with ideas, but also with people, don't hesitate to 'cold email' a researcher to ask a question about their research or seek advice about yours, and nurture good professional relationships with the goal of having them for your entire career. I reckon that computational and statistical fields are going to be a great source of inspiration for archaeologists in

the coming years, but there are many other fields that will be productive also. I'd also suggest approaching your participation in the research community as an anthropological problem: a big part of succeeding in academia is finding answers to the question of what are the unspoken norms that guide the behaviours of the members of that community (publishing, presenting, teaching, etc)? Participant observation is one rather slow way to answer this question, a way to speed this up is to become familiar with research on writing for publication, presenting your research, teaching, etc. Some of my favourites include The Science of Scientific Writing, Rethinking the Design of Presentation Slides: A Case for Sentence Headlines and Visual Evidence, and Active learning increases student performance in science, engineering, and mathematics. The Nature Careers blog posts are another great source of professional advice that I highly recommend for tips and inspiration on many of the little day-to-day things that we need to do in a research career.

How has academia changed since you did your PhD?

Some of the most exciting and positive changes are the development of quantitative methods of analysing artefacts to formalise modelling of cultural evolutionary processes. Methods for discriminating among different kinds of cultural transmission, and the computational tools for using these methods, have been really impressive at reviving efforts to answer basic questions that are at the core of archaeology. The refinement and application of geochemical methods to archaeological questions, especially the identification of biomolecules with mass spectrometry, has been amazing and fascinating. And of course, ancient DNA has improved our understanding of many major events in human evolution. Exciting organizational changes include the rise of team science and big projects with many participants, and open science, when the code and data are freely made public.

Perhaps the most striking change has been in demographics and diversity. It's great to see how archaeology has become increasingly accessible to people from many backgrounds that I rarely saw in the research community when I was doing my PhD. Community efforts to enable this accessibility through new teaching methods, new content in undergraduate classes, and dismantling the hidden curriculum, have been making a positive difference. These demographic shifts have highlighted the urgency of the task of updating and clearly communicating our professional ethics and norms of behaviour. For example, we have a lot of work to do to eliminate sexual harassment, bullying, and other bad behaviours that have been difficult to address because individual and institutional power and prestige have been valued more than our community's wellbeing and its sustainability. Events of 2019-2020 have especially shown that our existing scholarly and professional organisations are struggling to manage how academia generally, and archaeology in particular, have changed over the last decade. Despite these rising waves of discontent, I'm optimistic that our organisations and their leaders will catch up with the new norms, and restore their relevance to the community. I'm inspired by other fields, including some bigger and older than archaeology, who have been very nimble with their professional societies to update their codes of conduct and professional practices.

References:

Bruchac, M. (2014). Decolonization in Archaeological Theory. In Smith, C. (Ed.), *Encyclopedia of Global Archaeology*, pp. 2069-2077. New York: Springer Science and Business Media.

Clarkson, C., Jacobs, Z., Marwick, B., Fullagar, R., Wallis, L., Smith, M., Roberts, R. G., Hayes, E., Lowe, K., Carah, X., Florin, S. A., McNeil, J., Cox, D., Arnold, L. J., Hua, Q., Huntly, J., Brand, H. E. A., Manne, T., Fairbairn, A., Shulmeister, J., Lyle, L., Salinas, M., Page, M., Connel, K., Park, G., Norman, K., Murphy, T. and Pardoe, C. (2017). Human occupation of northern Australia by 65,000 years ago. *Nature,* 547, pp. 306–310. DOI:10.1038/nature22968.

Hu, Y., Marwick, B., Zhang, J., Rui, X., Hou, Y., Yue, J., Chen, W., Huang, W., and Li, B. (2019). Late Middle Pleistocene Levallois stone-tool technology in southwest China. *Nature,* 565, pp. 82–85. DOI:10.1038/s41586-018-0710-1.

Kretzler, I. and Marwick, B. (2014). Investigating Archaeologists' Engagement With Feminist Theory Using Textual Macroanalysis: 25 Years after Chacmool 1989. *BREAKING BARRIERS: Proceedings of the 47th Annual Chacmool Archaeological Conference.*

Marwick, B. (2009). Biogeography of Middle Pleistocene hominins in mainland Southeast Asia: A review of current evidence. *Quaternary International,* 202(2009), pp. 51-58. DOI:10.1016/j.quaint.2008.01.012

Marwick, B., Van Vlack, H. G., Conrad, C., Shoocongdej, R. and Thongcharoenchaikit, C. (2016). Adaptations to sea level change and transitions to agriculture at Khao Toh Chong rockshelter, Peninsular Thailand, *Journal of Archaeological Science,* 77, pp. 94-108. DOI: 10.1016/j.jas.2016.10.010

Marwick, B. and Birch, S. (2018). A Standard for the Scholarly Citation of Archaeological Data as an Incentive to Data Sharing. *Advances in Archaeological Practice*, 6(2), pp. 125-143. DOI:10.1017/aap.2018.3

Marwick, B. (2019). "Marwick_2008_PhD_Thesis_Revised.pdf", Stone artefacts and human ecology at two rockshelters in Northwest Thailand. Available at: https://doi.org/10.7910/DVN/UHIFDK/QZVQ8M, Harvard Dataverse, V1.

Marwick, B., Wang, L., Robinson, R., and Loiselle, H. (2020). How to Use Replication Assignments for Teaching Integrity in Empirical Archaeology. *Advances in Archaeological Practice*, 8(1), pp. 78-86. DOI:10.1017/aap.2019.38

Schmidt, S.C. and Marwick, B. (2020). Tool-Driven Revolutions in Archaeological Science. *Journal of Computer Applications in Archaeology*, 3(1), pp.18–32. DOI:10.5334/jcaa.29

Stodden, V., Seiler, J. and Ma, Z. (2018). An empirical analysis of journal policy effectiveness for computational reproducibility. *Proceedings of the National Academy of Sciences,* 115(11), pp.2584-2589. DOI:10.1073/pnas.1708290115

Ziman, J. M. (1981). *Puzzles, Problems and Enigmas: Occasional Pieces on the Human Aspects of Science*. Cambridge University Press. ISBN: 0521236592, 9780521236591.

Professor Chris Hunt[5]

Chris Hunt is an earth scientist, whose research interests primarily lie in Quaternary Science. He currently teaches primarily in Geography at Liverpool John Moores University, with a specific focus on past human-environment interactions. After completing his PhD at University College of Wales Aberystwyth, Chris has held many research positions, most recently at Royal Holloway University, the University of Huddersfield and Queen's University Belfast before taking up his professorship in Liverpool. He is founding editor of *Journal of Archaeological Science: Reports* and an editorial board member of *Journal of Archaeological Science*.

What are your research interests and particular area of expertise?

I am interested particularly in how humanity interacts with our environment, now and in the distant past and, of course, all points between. I'm interested in how our environmental behaviour has changed over time. I guess I use natural sciences techniques to throw light on human behaviour. My particular expertise is in palynology, stratigraphy, sedimentology, palaeoecology and reconstructing ancient environments and I have lesser expertise in molluscs.

What originally drew you towards archaeology when you were an undergraduate student?

As an undergraduate, I did Geography/Geology but I met a very lovely Archaeology student and attended some classes to see more of her. Sad really...

What current projects are you working on?

I am co-investigator on the Shanidar Project (Pomeroy et al., 2020), co-investigator of the FRAGSUS Project which has investigated societal and environmental change in Maltese prehistory (Hunt and Schembri, 2018; Ruffell *et al.*, 2018) and co-investigator on the Cyrenaican Prehistory Project which is investigating the past 300,000 years in North East Libya (e.g. Inglis *et al.*, 2018; Jacobs *et al.*, 2017). I also have active research in Borneo looking at ancient rainforest use (Barker *et al.*, 2018, 2007), at Petra where I'm part of a group led by Bernhard Lucke examining Nabatean agriculture, and in Ireland where I'm contributing to Richard Jennings' Ballymintra project exploring pre-Neolithic colonisation of Ireland and am writing up a series of samplings of middens in Co Sligo with Finbar McCormick and others (Hausmann *et al.*, 2019).

Where would you like these projects to go in the future?

I'm getting old, so I want to conclude my contribution to all these over the next few years. I hope that the Shanidar Project will develop - it's an amazing site with huge potential and I hope that Emma Pomeroy and our colleagues in the Kurdish Antiquities Service will take it forward, find new Neanderthals and lots of great cultural information over the next 10 years. There will be all sorts of stuff to do once all of these projects are finished. For instance, in Malta, our pollen evidence shows farming

[5] Department of Natural Sciences and Psychology, Liverpool John Moores University, UK; c.o.hunt@ljmu.ac.uk

several hundred years before the first archaeology (French *et al*., in press), and evidence continuity between the early and late Neolithic while there is no archaeological evidence in the gap in the middle. It must be there somewhere! Have we just not recognised it or found the right site? And there is still loads to do on the collapse of the Maltese Temple Culture. Our evidence gives an idea of coastal sites being abandoned and activity continuing inland (French *et al*., in press). There may be partial population replacement, but it's by no means certain. Our information is really still very insubstantial, and more work will be needed. The work on ancient rainforest use is at a very early stage. We are beginning to see long sequences of vegetation management in Borneo, with humans impacting rainforest since 50,000 years ago (Barker *et al*., 2007; Hunt *et al*., 2012). I would really like to do more work on this...

In relation to your most recent publication in Antiquity, do you think we have enough evidence to say that Neanderthals have elaborate mortuary/symbolic practises? Do you think they are behaviourally 'modern'?

This is the million-dollar question which I am wrapping up in a grant application at the moment. There are so many imponderables. They certainly looked after their injured, sick and lame. They seem to have done things with raptor feathers and claws that don't look dietary. They may have occasionally put geometric designs on cave walls and floors. The mortuary cluster at Shanidar suggests memory and return to sites to place their dead, if no more. The difficulty is that we are looking through the geomorphological filter which was the Last Glacial Maximum, so the evidence is not strong... but it is promising nonetheless!

What is it like to work at Liverpool John Moores University in the School of Biological and Environmental Sciences?

I have lovely and interesting colleagues, a great boss, super students and no pretensions. So, I feel I am very lucky. But LJMU is a poor institution financially, so we have a lot of 'Blue Peter' make do and mend and lots of students to look after.

How has academia changed since you did your PhD?

Hugely. It's much more like a business than it was and the number of administrators and the administrative load on academic staff have sky-rocketed out of all recognition. Health and safety is something we now have to strictly observe so there's lots of lab and field stuff we simply don't and can't do any more (in many ways not a bad thing!). Students are less able to afford to be curious and much more instrumental about what they choose to do, both in subject choices and in the way they approach work on their degree. I think the loan system may have caused this. I wrote two essays a week throughout my degree, but all my marks rested on the final exams. We struggle to get our guys to write one, unless credit is attached! Schools nowadays prepare students for university by focussing on passing assessments, so they know little else and are far less sure of themselves than my generation were, 45 years ago. It's a shame as a lot of them are very bright!

Shandiar Cave, Iraq, where Chris and his colleagues have recently found evidence for elaborate Neanderthal mortuary behaviour.

What is your best advice to an archaeology PhD student embarking on a career in academia?

Do something that really interests you! And don't necessarily expect a career in academia. Most of the people I started with didn't become academics, some out of choice others not. But most would say that the time spent doing a PhD was really rewarding and exciting. And don't think that because you started doing one thing, you have to do it for the rest of your life! The PhD shows that you have bucketloads of intelligence, problem-solving ability and sheer grit. Employers like these qualities, as long as you aren't precious about it. If you really want an academic career, you have to hang in there and keep publishing, while doing other jobs till your opening comes along. I did 4 years consultancy and lots of odd jobs between finishing my grant and getting my first permanent job. But I kept publishing. Very hard! Finally, remember to keep perspective. A PhD thesis needs to be a very good piece of work, but don't try to make it perfect. It's a trap lots of people blunder into. Better a good thesis after 3.5 years than a great but unfinished one!

References:

Barker, G., Barton, H., Bird, M., Daly, P., Datan, I., Dykes, A., Farr, L., Gilbertson, D., Harrisson, B., Hunt, C., Higham, T., Kealhofer, L., Krigbaum, J., Lewis, H., McLaren, S., Paz, V., Pike, A., Piper, P., Pyatt, B., Rabett, R., Reynolds, T., Rose, J., Rushworth, G., Stephens, M., Stringer, C., Thompson, J. and Turney, C. (2007). The 'human revolution' in lowland tropical Southeast Asia: the antiquity and behavior of anatomically modern humans at Niah Cave (Sarawak, Borneo). *Journal of Human Evolution,* 52(3), pp. 243-261. DOI: 10.1016/j.jhevol.2006.08.011.

Barker, G., Hunt, C., Hill, E., Jones, S. and O'Donnell, S. (2018). 'Rice needs people to grow it': Foraging/farming transitions and food conceptualization in the highlands of Borneo' In E. Lightfoot, X. Liu, and D. Q. Fuller (Eds.), *Far from the Hearth*, McDonald Institute for Archaeological Research: McDonald Institute Conversations. DOI: 10.17863/CAM.38323.

French, C., Hunt, C.O., Grima, R., McLaughlin, R., Stoddart, S. and Malone, C. (in press). *Temple Landscapes: Fragility, change and resilience of Holocene environments in the Maltese Islands*. Cambridge, McDonald Institute Monographs, pp-335.

Hausmann, N. B. M. J., Robson, H. K. and Hunt, C. (2019). Annual growth patterns and interspecimen variability in Mg/Ca records of archaeological *Ostrea edulis* (European Oyster) from the Late Mesolithic site of Conors Island. *Open Quaternary*, 5(9), DOI: 10.5334/oq.59.

Hunt, C. O., Gilbertson, D. D. and Rushworth, G. (2012). A 50,000-year record of Late Pleistocene tropical vegetation and human impact in lowland Borneo. *Quaternary Science Reviews,* 37, pp. 61-80. DOI: 10.1016/j.quascirev.2012.01.014.

Hunt, C. and Schembri, P. J. (2018). Historic-period terrestrial environments and soil erosion in the Maltese Islands : evidence from molluscs assemblages from cave-fills at Għajn il-Kbira, near Victoria, Gozo. In N. C. Vella, A. J. Frendo and H. C. R. Vella (Eds.), *The Lure of the antique: essays on Malta and Mediterranean archaeology in honour of Anthony Bonanno*. Leuven-Paris-Bristol: Peeters Publishers, pp. 67-74.

Inglis, R. H., French, C., Farr, L., Hunt, C., Jones, S. C., Reynolds, T. and Barker, G. (2018). Sediment micromorphology and site formation processes during the Middle and Later Stone Ages at the Haua Fteah Cave, Cyrenaica, Libya. *Geoarchaeology*, 33(3), pp. 328-348. DOI: 10.1002/gea.21660.

Jacobs, Z., Li, B., Farr, L., Hill, E., Hunt, C., Jones, S., Rabett, R., Reynolds, T., Roberts, R.G., Simpson, D. and Barker, G. (2017). The chronostratigraphy of the Haua Fteah cave (Cyrenaica, northeast Libya) — Optical dating of early human occupation during Marine Isotope Stages 4, 5 and 6. *Journal of Human* Evolution, 105, pp. 69-88. DOI: 10.1016/j.jhevol.2017.01.008

Pomeroy, E., Bennett, P., Hunt, C., Reynolds, T., Farr, L., Frouin, M., Holman, J., Lane, R., French, C. and Barker, G. (2020). New Neanderthal remains associated with the 'flower burial' at Shanidar Cave. *Antiquity,* 94(373), pp. 11-26. DOI: 10.15184/aqy.2019.207.

Ruffell, A., Hunt, C., Grima, R., McLaughlin, R., Malone, C., Schembri, P., French, C. and Stoddart, S. K. F. (2018). Water and cosmology in the prehistoric Maltese world: Fault control of the hydrogeology of Ġgantija, Gozo (Maltese Islands), *Journal of Archaeological Science: Reports,* 20, pp. 183-191, DOI: 10.1016/j.jasrep.2018.05.002.

Professor Andy Herries[6]

Andy Herries is Head of the Department of Archaeology and History at La Trobe University in Australia! Andy is a field palaeoanthropologist, geochronologist and geoarchaeologist, running The Australian Archaeomagnetism Laboratory (TAAL). TAAL applies magnetic and geophysical methods to the study of archaeological sites and artefacts. He also directs two field projects in South Africa - The Drimolen Cave Palaeoanthropology and Geoarchaeology Field School, looking at the transition from *Australopithecus* to early *Homo* and *Paranthropus*, and the Amanzi Springs Archaeology Project, looking at the transition from the Acheulean to the Middle Stone Age.

What are your research interests and particular area of expertise?

My main focus has been on the geoarchaeology and geochronology of human origins, particularly in southern Africa, through the use of palaeomagnetism. I work as both a specialist on archaeological and fossils sites where I fly in and take samples and return to the lab to run them, as well as a field archaeologist and site director. My main interest is providing a chronology for hominin evolution and understanding the transition from the Acheulian to the Middle Stone Age. However, I have a very diverse publishing background based on the fact that archaeomagnetism can be used on almost all time periods and I have published papers on 19th Century Melbourne bricks, modelling Chacma Baboon distributions, and I've just had a joint authored paper accepted on fossil wombats. I love this diversity in research.

What originally drew you towards archaeology and anthropology?

I never remember not wanting to be an archaeologist. I always used to say that I wanted to be an archaeologist since I was 6. However, a few years ago my grandmother told me that when I was three I asked for her toffee hammer to go out into the garden to break rocks to find fossils. So not much has changed. I was lucky enough to grow up in the United Arab Emirates and travel to Egypt, Greece, Italy, and Sri Lanka with my parents so I was immersed in archaeology from a very early age. I went on my first excavation when I was 16 with University College London at Beddingham Roman Villa in East Sussex. Consequently, when I went to the University of Liverpool and studied Archaeological Science I had visited many of the places being talked about in class. However, when I sat in a first year subject where Prof John Gowlett talked about early hominins in Africa I found it fascinating as I knew so little about it, and I was hooked from that point on Palaeoanthropology. In my second year John was on sabbatical and so I got classes from John McNabb and that gave me a wonderful grounding in stone tool technology, which I used for my honours on Australian stone tools. My becoming involved in African archaeology came about because I was a caver and Anthony Sinclair at Liverpool invited me on the Makapansgat Middle Pleistocene Research Project because they wanted to explore for new caves in South Africa. At this point in my life I was all ready to become a hominin palaeobiologist but, with Bernard Wood leaving Liverpool for the US, and my trip to South Africa prompted me to move into geoarchaeology instead and study cave geology.

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[6] Department of Archaeology and History, La Trobe University, Australia; a.herries@latrobe.edu.au

What was your PhD topic? How did you choose this and who was your supervisor?

My PhD was "Magnetostratigraphic seriation of South African hominin palaeo caves". When I started it in 1999 there were really no good ages for the South African hominin sites, which were mostly based on faunal correlation. I had done a stratigraphic study of the Makapansgat Limeworks hominin site in South Africa for my MSc and so my supervisor, Alf Latham suggested the next natural step was to do a paleomagnetic study to look at the age of the site, expanding what had been done in the 1970s. I did this in the Geomagnetism Laboratory at Liverpool under the supervision of Prof John Shaw and in collaboration with the Makapansgat Field School run by Kaye Reed of Arizona State University and Kevin Kuykendall then of the University of the Witwatersrand. After I started I then got asked to work on several other sites in the Cradle of Humankind including Sterkfontein, Gondolin, and Gladysvale.

Excavating a horn core at the Cornelia hominin site in South Africa with John Gowlett and James Brink (2001). Photo by John Gowlett.

Since your PhD, what academic positions have you held?

Right after my PhD I was a post-doctoral fellow with Mary Kovacheva on the European Union funded Archaeomagnetic Applications for the Rescue of Cultural Heritage (AARCH) at the Geophysical Institute of the Bulgarian Academy of Sciences in Sofia, Bulgaria. This is the only job I have had that did not focus on Palaeoanthropology as I worked on the archaeomagnetic dating of Bronze Age and Mediaeval Pottery kilns. However, it was a job that taught me a lot of the skills I later needed to set up my own laboratory and diversify my archaeomagnetic research. Because of the networks from this job I still have many friends at magnetics laboratories all across Europe. During this position I also started working at Pinnacle Point in South Africa with Curtis Marean looking at pyrotechnology and stone tool heat treatment in the Middle Stone Age. Working with Curtis Marean and his team was really the

foundation of the way I run excavations and projects and introduced me to some of the top scientists in the field. My work here led to my first papers in *Nature* and *Science*, which really helped me to get a number of later fellowships and propelled my career. In 2005 I moved to the University of New South Wales Dept. Anatomy on a NewSouth Global Post-doctoral Fellowship where I worked on some Later Stone Age sites as well as continuing work at Pinnacle Point. During this period I also started working back in the Cradle of Humankind at Gondolin. I was successful with an Australian Research Council Australian Research (ARC) Fellowship at UNSW in 2008 to work on fossil sites in China and excavated Red Deer Cave in Yunnan Province, but continued doing magnetics research on South African sites during this period including at Cornelia, Bolt's Farm, Malapa, Taung and Drimolen. My time at Cornelia with my late friend James Brink was a foundation of my knowledge in excavating fossil material that would become so useful at Drimolen. I also started work with John Gowlett in Kenya at Kilombe, a project I remain connected to today. In 2012 I was successful with an ARC Future Fellowship at La Trobe University where I also set up The Australian Archaeomagnetism Laboratory (TAAL) and continued to work on many of these same sites, as well as at Rising Star. This period was when my long term colleague Robyn Pickering, now at the University of Cape Town, was also in Melbourne on an ARC Fellowship and cemented our working relationship, leading to our recent paper in *Nature* on the chronology of South African sites. During this period I also started a Field School at Drimolen, becoming the joint permit holder with Stephanie Baker of the University of Johannesburg's Palaeo-Research Institute in 2017, and began early research at the Acheulian site of Amanzi Springs with Matt Caruana. I became the Head of Dept. of Archaeology and History at La Trobe in 2018 and was promoted to Professor.

Excavations being run at the 2.61-million-year-old Drimolen Makondo fossil site, with Canadian field school student Samantha Good.

What current projects are you working on in The Australian Archaeomagnetism Laboratory (TAAL)?

TAAL works on projects across a lot of time ranges and current projects include palaeomagnetic analysis of Oldowan and Acheulean sites at Kilombe in Kenya, the *Paranthropus robustus* site of Kromdraai, fossil sites in Saudi Arabia, Acheulian sites in Jordan, archaeological and marsupial fossil sites in Australia, early Copper production in Oman, and a lot of commercial projects in Australia. These latter projects are part of the lab's efforts to build the first comprehensive Archaeomagnetic Dating curve for south eastern Australia.

What are the aims of the Drimolen Cave and Amanzi Springs Archaeology projects? What have been the most memorable finds so far?

The aim of our research at Drimolen is to try and understand the changing landscapes, climate and species that occur between the newly discovered older deposits of the Drimolen Makondo (~2.6 Ma) when *Australopithecus africanus* was on the landscape and the younger ~2.0 Ma Drimolen Main Quarry when *Paranthropus robustus* and *Homo erectus* first occur along with bone and stone tools. The discovery of the Drimolen Makondo has taught us a lot about the geology at the site at it was not extensively mined like the Main Quarry, that was the focus of excavations over the last 26 years. The discovery of the DNH 134 *Homo erectus* cranium, the oldest fossil of this species, is by far the most significant find made at the Main Quarry since the discovery of the DNH 7 *Paranthropus robustus* cranium back in 1994, and has shown the site has the potential to yield more complete specimens. In 2018 we also discovered a number of other crania and in 2019 a partial skeleton so there are some other big announcements on the horizon. At Amanzi Springs our project has so far focused on trying to date the deposits and try to understand the relationship between the Acheulian artefacts and newly identified Middle Stone Age deposits. The most significant discovery to date is a layer in the Acheulian that contains a significant amount of preserved wood. Both projects are run jointly with researchers at the Palaeo-Research Institute at the University of Johannesburg that I have been partly involved in establishing in recent years. It's extremely important to get more South Africans involved in Palaeoanthropology and running sites in South Africa. Hence the Drimolen Field School has supported the honours program training at UJ and we provide scholarships for African students to come on the field school. At Amanzi we have had lots of students from the University of Cape Town come to excavate with us.

What project or publication are you most proud of from your academic career so far?

Obviously I have just published my first, 1st author paper in *Science* on the age of the Drimolen site and the DNH 134 *Homo erectus* cranium (Herries *et al*., 2020). The discovery and publishing of a significant hominin crania by a team I lead has been a lifelong ambition so it certainly tops the list. I'm also proud of it because of the many PhD students involved, and I've been lucky to have a lot of excellent junior colleagues involved on my projects. I hope that Drimolen gives them opportunities in the same way that working on projects like Pinnacle Point with Curtis Marean gave me. But this paper is ultimately just the start of our publications from Drimolen and some quite significant publications are also on the horizon for Amanzi Springs we hope. I'm also pretty proud of my first paper in Science in 2009 where we published the oldest evidence for the heat treatment of rock to make stone tools at Pinnacle Point as this paper really seemed to set off debate within the discipline (Brown *et al*., 2009). My paper on the age of Sterkfontein is also one I'm fond of because it gave some of the first ages for iconic fossils like Mrs Ples (Herries and Shaw, 2011) and when Robyn Pickering came along afterwards and uranium-lead dated the site she got the same answer for the ages independently (Pickering *et al*., 2011). This set off a long collaboration that culminated in our paper in *Nature* together last year showing that speleothems form across the Cradle of Humankind caves and can be used to cross correlate in a similar way to

volcanic tuffs in eastern Africa, which is just very cool (Pickering *et al.*, 2019). Other papers, like my 2019 paper with Renaud Joannes-Boyau in *Nature* also show how technology is changing the discipline of palaeoanthropology in ways I could never have imagined when I started over 20 years ago.

Andy with a 3D print of the recently published DNH 134 Homo erectus cranium

What is your favourite and worst thing about academia? What would you change if you could?

My favourite thing is that I am able to get up every day to do something I love and for the most part decide what I want to research each day. I also love interacting with my PhD students and trying to help them to full-fill their dreams and career wishes. That love of teaching is the same reason I run the Drimolen Field School as I want to both inspire undergraduate students into palaeoanthropology like John Gowlett inspired me and also help to provide opportunities for South African students to work in the field. The worst thing about academia is that it is hard to relax and switch off because you always have something that needs doing, some deadline coming up. It makes creating a work life balance a challenge (It's currently 1.30 am as I write this!). This has often led me into a lot of extreme sports in my spare time as frightening the hell out of myself gets rid of the stress and I don't think about work, but that's more difficult now with young kids. The thing I would change if I could would be the lack of jobs available, especially for students when they first finish their PhD. Sadly, COVID has made the academic job market even bleaker for graduates hoping to go into academia, although in Victoria there are actually a shortage of archaeologists in the commercial sector so many of our graduates go straight into jobs at the moment.

References:

Brown, K. S., Marean, C. W., Herries, A. R., Jacobs, Z., Tribolo, C., Braun, D., Roberts, D. L., Meyer, M. C. and Bernatchez, J. (2009). Fire as an engineering tool of early modern humans. *Science,* 325(5942), pp. 859-862 DOI: 10.1126/science.1175028.

Herries, A. I. R. and Shaw, J. (2011). Palaeomagnetic analysis of the Sterkfontein palaeocave deposits: implications for the age of the hominin fossils and stone tool industries. *Journal of Human Evolutio*n, 60(5), pp. 523-39. DOI: 10.1016/j.jhevol.2010.09.001.

Herries, A. I. R., Martin, J. M., Leece, A. B., Adams, J. W., Boschian, G., Joannes-Boyau, R., Edwards, T. R., Mallet, T., Massey, J., Murszewski, A., Neubauer, S., Pickering, R., Strait, D. S., Armstrong, B. J., Baker, S., Caruana, M. V., Denham, T., Hellstrom, J., Moggi-Cecchi, J., Mokobane, S., Penzo-Kajewski, P., Rovinsky, D. S., Schwartz, G. T., Stammers, R. C., Wilson, C., Woodhead, J. and Menter, C. (2020). Contemporaneity of *Australopithecus, Paranthropus*, and early *Homo erectus* in South Africa. *Science*, 368(6486). DOI: 10.1126/science.aaw7293.

Joannes-Boyau, R., Adams, J.W., Austin, C., Arora, M., Moffat, I., Herries, A.I.R., Tonge, M.P., Benazzi, S., Evans, A.R., Kullmer, O., Wroe, S., Dosseto, A., Fiorenza, L. (2019). Elemental signatures of Australopithecus africanus teeth reveal seasonal dietary stress. *Nature,* 572, pp. 112-115. DOI: 10.1038/s41586-019-1370-5.

Pickering, R., Dirks, P. H. G. M., Jinnah, Z., de Ruiter, D., Churchil, S. E., Herries, A. I. R., Woodhead, J. D., Hellstrom, J. C. and Berger, L. R. (2011). *Australopithecus sedia* at 1.977 Ma and implications for the origins of the genus *Homo*. *Science,* 333(6048), pp. 1421-1423. DOI: 10.1126/science.1203697.

Pickering, R., Herries, A. I. R., Woodhead, J. D., Hellstrom, J. C., Green, H. E., Paul, B., Ritzman, T., Strait, D. S., Schoville, B. J. and Hancock, P. (2019). U-Pb-dated flowstones restrict South African early hominin record to dry climate phases. *Nature*, 565, pp. 226-229. DOI: 10.1038/s41586-018-0711-0.

Part 2: Palaeolithic Archaeology

Professor Shanti Pappu[7]

Professor Shanti Pappu is the founder/secretary of the Sharma Centre for Heritage Education, a non-profit organisation aimed at promoting research in archaeology and developing educational programmes for children and teachers on Indian heritage, that she runs with Dr. Kumar Akhilesh. She is a former Professor of Prehistory at the Deccan College Postgraduate and Research Institute, where she also completed both her MA and PhD degrees and was awarded the Prof H.D. Sankalia Gold Medal. She also has a law degree, with a dissertation based on cultural heritage laws of India, and is a registered advocate. Her research interests span a wide range of topics within human evolution studies, such as lithic studies, palaeoenvironments, ethnoarchaeology, the history of archaeology and public archaeology.

What are your research interests and your particular area of expertise?

Looking back in time; travelling down the complex trails in the story of human evolution, and examining ways in which our bodies and minds have evolved, is something that fascinates me. Indian prehistoric sites primarily have stone artefacts, with sparse fossil remains, and the real crux of interpreting past behaviour lies in decoding these silent stones. This forms the basis of our studies at the Sharma Centre for Heritage Education.

It is also really exciting to collaborate with scientists from different disciplines, each contributing a little piece to the puzzle of hominin behaviour in India, always realizing that the truth may be one step ahead of us. I am also fascinated by ethnoarchaeology (Pappu, 2006) and aspects of the history of archaeology in South Asia.

What originally drew you towards human evolution studies?

The past has always held a great fascination. My parents, grandparents, and aunts plied me with books, not only on archaeology but also on evolution. The overall atmosphere in Kolkata, where I grew up, was one permeated with an appreciation of the past, and with a wonderful culture of reading. However, we never had a chance to actually visit excavations, or learn about prehistory, and that is one of the main reasons why we now focus on a lot of hands-on activities in workshops in our children's museum.

[7] Sharma Centre for Heritage Education, Tamil Nadu, India; pappu.shanti@gmail.com

The research team at the Sharma Centre for Heritage Education in action.

My parents were very supportive, something very unusual for India, and later my husband and his family (with his father and sister also being archaeologists) were equally enthusiastic, especially with my long absences in the field. My primary interest in prehistory however, came from the Deccan College post-graduate and research Institute, Pune, where I did my Masters and PhD degrees.

The spirit of the 'father of Indian archaeology', Prof. H.D. Sankalia, was all around us, even though he had just passed away, and one could not escape the flavour of prehistory that permeated the old buildings and wonderful library. It was a time marked by intense intellectual fermentation in Indian prehistory, when debates on processual and post-processual theories, landscape archaeology, site-formation and ecological concepts brought the subject alive, moving away from the traditional listing of tool types and Quaternary sections. New dates were coming in and being vigorously debated. Doctoral theses and research on important sites like those of Bhimbetka, Samnapur, the Didwana complex, the Hunsgi-Baichbal complex, Mehtakhedi, among others were being actively discussed. Lectures by Professors V.N. Misra, K. Paddayya, S.N. Rajaguru, Sheila Mishra, Malti Nagar, P.K. Thomas, M.D. Kajale, G.L. Badam, amongst others, were deeply inspiring, more so at a time when the beauty of the subject was conveyed without any visual aids: just a blackboard, lab specimens, the museum, and the passion of the teacher. Attending excavations at Samnapur, Mehtakhedi, Budihal, and surveys in Western and Central India and the Hunsgi-Baichbal basin brought alive the questions of global importance that excavators were tackling. Visiting scholars from India and abroad added a global touch. Above all, the Deccan College library was marvellous, with all the latest books and journals keeping us updated before the age of the internet.

What was your PhD topic? How did you choose this and who was your supervisor?

This had a rather prosaic title and was later updated and brought out as a book (Pappu, 2001) and I was enrolled at the Deccan College under Professor K. Paddayya. One of my examiners was Professor Derek Roe, whom I had the pleasure to meet years later, and his constructive comments were very useful in bringing out the book. Historically, the study area is a very important region in Indian archaeology. The first Palaeolithic artefacts in India were discovered here, in 1863, by Robert Bruce Foote (Pappu, 2008), who also discovered the site of Attirampakkam (ATM), that our team is currently researching.

After Foote, the famous Yale–Cambridge Expedition of the 1930s proposed models of river terrace sequences and associated cultural phases in this region, as they did elsewhere in the subcontinent. Terms such as 'Madras Handaxe Tradition', or variants of this, as opposed to the non-biface 'Soanian' assemblages of South Asia, arose from discoveries in this region. Later, excavations were conducted here by the Archaeological Survey of India, with different insights. Despite all this, actually very little was published at the time, and I thought it would be interesting to re-examine issues related to the stratigraphic context of sites, landscape scales of understanding prehistoric mobility, lithic reduction sequences, and site formation processes, amongst other questions. With the help of Prof. S.N. Rajaguru, we could revise the old terrace models and propose new ideas for Quaternary landscape formation. Observations on local hunter-gatherers was very insightful, although how far these analogies may be applied to the Palaeolithic may be debated. This work set the stage for our later research in this region, now bringing in large collaborating teams of scientists.

After your PhD, what positions have you held and where?

Well, I never got an academic job after my PhD! I worked for a software company for a while, a super experience in learning skills that have served me well today, and they helped me in developing a portal called Dig: Discover India Gallery, primarily on India's ancient heritage. In 1999, with my family's help, we began a non-profit educational Institute (Sharma Centre for Heritage Education) with the aims of promoting research in archaeology and developing educational programs for children and teachers of Indian heritage (Pappu, 2000; Pappu and Akhilesh, 2019b). We also established a tiny children's museum. From this modest beginning, with the enormous support of my family, my colleague Akhilesh and I are focused on building our Institute for both research and outreach. For a short while, I joined as Professor of Prehistory at the Deccan College, but left owing to commitments in building up our own Centre.

What current projects are you working on? Have you got any interesting results so far?

For several decades now, Akhilesh and I have been directing a long-term research project on 'Prehistory and Palaeoenvironments in Southeast India' with a number of sub-projects and a wonderful team of Indian and foreign collaborating scientists (see below). This rather simple title contains fascinating projects packed with exciting research into early hominin occupation in India, with surveys of Palaeolithic landscapes, excavations, experimental studies, geochronology, and studies of Quaternary environments.

Our team began with a project of excavating Attirampakkam (hereafter ATM) in 1999, and we are still researching this fantastic site. With numerous trenches, a huge sample size, geomorphological studies, and multiple dating methods, we could establish that these were early Pleistocene, pushing back the antiquity of occupation of South Asia by Acheulian cultures. Dr. Maurice Taieb was at that time in India, and greatly encouraged us in this project. We also found a wonderful stratified sequence of assemblages, with horizons displaying processes transitional to and of the early Middle Palaeolithic (MP), and were able to date these as well, generating new debates in South Asian archaeology. Studies of lithic assemblages and experimental knapping programs by Akhilesh, to replicate these technologies are ongoing, and already resulting in exciting thoughts on hominin behaviour at the site, cognitive abilities, skills at mastering technologies, for e.g. the Kombewa, and aspects of group sizes (Akhilesh and Pappu, 2015; Pappu and Akhilesh, 2019a). With our colleagues, we are also slowly building up a picture of local environments at the site through geomorphology, mineral magnetics, clay mineralogy, and phytoliths. Now we are expanding our work with excavations at the neighbouring site of Sendrayanpalayam, which we hope will provide a better picture of regional scales of adaptation and varying facies of Indian Lower Palaeolithic cultures and technologies. Another forthcoming project involves exploring more recent prehistoric cultures at the southernmost tip of India, exploring how modern humans migrated and adapted to differing environments and sea-level changes (Pappu *et al.*, 2011; Goren-Inbar *et al.*, 2015;

Akhilesh *et al*., 2017, 2018). None of these projects would have come through without the help of our Centre and more so my family. My parents, husband and aunts are involved at every stage, with my father now reading extensively on human evolution, and aiding us in statistical analysis of the data. We have been very fortunate with obtaining funding from many organisations (Homi Bhabha Fellowships, The Leakey Foundation, Earthwatch Institute, National Geographic Society, CNRS, Institut Universitaire de France, Fundación Palarq), and the Archaeological Survey of India and Department of Archaeology, State Government of Tamil Nadu have always given us licenses to work.

An on-site workshop with a local school held by the team at the Sharma Centre for Heritage Education

What has been your favourite memory from the field?

There are so many memories and more to come, I hope: both from the long-dead and from the living. From a research perspective: the fascinating discovery of the Acheulian in a totally new and unsuspected stratigraphic context at ATM was exciting, as is everything else associated with this site. Our recent excavations at the neighbouring Palaeolithic site of Sendrayanpalayam is bringing out new results that we are currently examining. The excitement of finding conjoinable tools even as we excavate, and recent surveys of the landscapes with new discoveries of very rich sites are some of the many memories. On another level, it is the villagers we have worked with closely for over 20 years, the colleagues from India and abroad with whom we have moved from professional to personal friendships, and my family, who has spent many hours in the heat and dust at our excavations, trying to understand our research, and aiding in every possible way. On a further level, it is our outreach, with schools bringing children and teachers, to visit us and neighbouring villagers dropping in to see the excavations and our little on-site exhibition in Tamil and English. Not to mention the visiting cobras, whose peaceful life we often disturbed.

During excavations, Shanti and her team invite local schools and organise activities, such as hands-on sessions with fossil casts, art, story writing and explanations about excavations, the Palaeolithic and stone tools.

What project or publication are you most proud of?

Well, I guess we are happy with our publications, some of which have been praised, others generating debates, but all written based on careful and cautious interpretations. Some of our hypotheses are gradually being supported by new research in India and elsewhere. The project at ATM is close to our heart, and we are very excited about the new project at Sendrayanpalayam. In the end, I think, we are grateful that a team led by us, with amazing colleagues from India and abroad, are placing South Asian prehistory on the global map.

What do you think has been the most revolutionary discovery in your field over the last 5 years?

I am fascinated by the discoveries of fossil hominins, and stone tools from Africa and parts of Asia, and the global genetic studies that are resulting in our traditional time scales and textbooks evolving every minute! It would be unfair to pin down any one discovery. I rather see all our contributions, whether big-impact or small observations, as pieces of an intricate puzzle that only team work and joint efforts can aid in solving.

What would you be if you were not a paleoanthropologist?

I always wanted to be an archaeologist, not much doubt there, perhaps any field of archaeology. I still wish to explore rock art and early agro-pastoral communities. Outside this field: well, perhaps a struggling artist.

Acknowledgements:

I would like to thank Dr. Kumar Akhilesh and Professor Yanni Gunnell and her parents, for critically slashing through her early drafts of this piece.

References:

Akhilesh, K., Pappu, S., Rajapara, H. M., Gunnell, Y.,Shukla, A.D., and Singhvi, A. K. (2018). Early Middle Palaeolithic Culture in India around 385-172 ka reframes Out of Africa models, *Nature,* 554, pp.97-102. DOI: 10.1038/nature25444.

Akhilesh, K., Pappu, S., Ravindranath, S. and Raj, U. (2017). Shifting Sands: A Review of Research on Microlithic Sites associated with Teri Dunes of Tamil Nadu, In: K.Paddayya, and B.Basak (Eds.), *Prehistoric Research In the Indian Subcontinent A Reappraisal and New Directions.* Primus Books, Delhi, pp. 215-236.

Akhilesh, K. and Pappu. S. (2015). Bits and pieces: Lithic waste products as indicators of Acheulean behaviour at Attirampakkam, India, *Journal of Archaeological Science: Reports,* 4 (2015), pp. 226–241.

Goren-Inbar, N., Melamed, Y., Zohar, I.,Akhilesh, K. and Pappu, S. (2015). *Beneath Still Waters - Multistage Aquatic Exploitation of Euryale ferox (Salisb.) during the Acheulian*, by, in *Internet Archaeology, 37. Special issue Human Exploitation of Aquatic Landscapes*. A special issue edited by Ricardo Fernandes and John Meadows.

Pappu, S. and Akhilesh, K. (2019a). Tools, Time and Trails: Debating Acheulian group size at Attirampakkam, India. *Journal of Human Evolution,* 130 (2019), pp. 109-125. DOI: 10.1016/j.jhevol.2019.02.004.

Pappu, S. and Akhilesh, K. (2019b). Heritage Management and Public Archaeology in the Context of Indian Prehistory. In V.Selvakumar and M.Koiso (Eds.), *Historical and Archaeological Heritage Management and Cultural Tourism in India and Japan: Issues, and Prospects for Development,* Tamil University, Thanjavur, India and Kobe Yamate University, Kobe, Japan, pp. 181-192.

Pappu, S., Gunnell, Y., Akhilesh, K., Braucher, R., Taieb, M.,Demory, F., and Thouveny, N. (2011). Early Pleistocene Presence of Acheulian Hominins in South India. *Science,* 331(6024), pp. 1596-1599. DOI: 10.1126/science.1200183.

Pappu, S., Akhilesh, K.,Ravindranath, S. and Raj, U. (2010). Applications of Satellite Remote Sensing for Research and Heritage Management in Indian prehistory. *Journal of Archaeological Science,* 37: pp. 2316–2331. DOI: 10.1016/j.jas.2010.04.005.

Pappu, S. (2008). Prehistoric Antiquities and Personal Lives: The Untold Story of Robert Bruce Foote, *Man and Environment*, XXXIII(1): pp. 30-50.

Pappu, S. (2006). Ethnoarchaeological research in Indian prehistory. In G. Sengupta, S. Roychoudhury and S. Som (Eds.), *Past and Present: Ethnoarchaeology in India*, Pragati Publications, New Delhi, in collaboration with Centre for Archaeological Studies and Training Eastern India, pp.43-58.

Pappu, S. (2001). *A Re-examination of the Palaeolithic Archaeological Record of Northern Tamil Nadu, South India* Oxford: BAR-International Series 1003.

Pappu, S. (2000). Archaeology in Schools: An Indian Example, *Antiquity,* 74(2000): pp. 485-6. DOI: 10.1017/S0003598X00059779 .

Professor Michael Petraglia[8]

Michael Petraglia is a prehistoric archaeologist at the Max Planck Institute for the Science of Human History! Michael's research is interdisciplinary and covers a range of subjects concerning human evolution, such as the evolution of cognition and behaviour, and the relationship between climate change and hominin dispersals. He has directed archaeological field projects in Africa and Asia, primarily in the Arabian peninsula and the Indian subcontinent, and is also part of the Human Origins Program Team at the Smithsonian Institute National Museum of Natural History.

What are your research interests and your particular area of expertise?

I think of myself as an interdisciplinary archaeologist, meaning that I integrate a wide range of disciplines into my research. While the core of my research is in archaeology, my publications reflect collaborations with a wide range of researchers in the earth sciences, biological anthropology and genetics. I am currently involved in projects of all sorts, ranging from the earliest occupations of Olduvai Gorge in Tanzania, to the review of the Pleistocene hominin record of China, to the adaptation of Holocene pastoral communities in Arabia. In particular, I have an intense interest in the origin and dispersal of our species, *Homo sapiens*, so my projects involve the excavation of Panga ya Saidi in Kenya, the investigation of Middle Palaeolithic sites in Saudi Arabia, and research on the Late Pleistocene record of South Asia, now mostly centered on cave and coastal excavations in Sri Lanka.

What originally drew you towards archaeology and human evolution studies specifically?

My interest in archaeology began when I was very young, and I was somewhat obsessed with the cultural history of Egypt. My sister Maria gave me a book on mummies, and my bedroom shelves eventually filled with books on Egyptian dynasties.

My interest in human evolution began when I was a teenager and I was awed with the book, *Origins* by Leakey and Lewin (1977). My sister Maria frequently purchased tickets to attend public lectures on the evolution of primates and humans at the American Museum of Natural History in NYC, where I got to hear first-hand accounts from Richard Leakey, Jane Goodall, Cliff Jolly and other famous anthropologists.

My first archaeological field work was in New York where I grew up. I had the chance to excavate Native American and historic sites with local museums and universities. While I was an undergraduate in Anthropology at NYU, I took archaeology courses with Howard Winters (a key figure in the 'New Archaeology') and Noel Boaz (who was working on the Pleistocene of North Africa, and who oversaw my dissection of a chimpanzee!). During my undergraduate years at NYU, I volunteered at the AMNH

[8] Max Planck Institute for the Science of Human History, Jena, Germany; petraglia@shh.mpg.de

working with the curator David Hurst Thomas, who set me up on a project in Nevada with Bob Kelly, then a doctoral student at Michigan. During my participation in the Great Basin surveys, I was positively influenced by Lewis Binford's students, and soon after, I moved to Albuquerque as a graduate student at the University of New Mexico.

What was your PhD topic? Where did you complete your PhD and who was your supervisor? How did you find your PhD experience?

I attended the University of New Mexico for my Masters and doctoral degrees. One of the main reasons I went to UNM was to study with the 'Father of the New Archaeology', Lewis Binford. At UNM, I was enthused to listen to Binford's stimulating lectures relating to many aspects of archaeology, human origins and early human behaviours. Binford's lectures were rather astounding as he was a talented orator.

Though I had planned to do my PhD with Binford, Lawrence Straus invited me to work with him in France, which I took up immediately! My PhD topic was on site formation processes at the Abri Dufaure, a Magdalenian site in southwest France. In the 1980s, the topic of site formation was all the rage, so I designed field plot experiments in Jemez, New Mexico, to observe how natural processes interacted with artefacts, moving and burying them. I was able to write this experimental work up as part of an independent study with Straus and this is what eventually led me to his excavation in France. I centered my PhD on evaluating the formation of Abri Dufaure's rockshelter and slope deposits (Petraglia *et al.,* 1994), but more than that, I was exposed to Palaeolithic archaeology for the very first time, which I found completely fascinating.

Mike recording excavations at the Abri Dufaure, Southwest France (1984). Lawrence Straus in lower right-hand corner.

While at UNM, the well-known Indian archaeologist, K. Paddayya, came to Albuquerque to learn more about the topic of site formation. Paddayya invited me to India to help him assess his Lower Palaeolithic sites in southern India, and so I travelled there during my postdoctoral work at the Smithsonian, leading to some great discoveries of intact Acheulean sites (Petraglia *et al.,* 1999).

Excavation of the Acheulean site of Isampur Quarry, Hunsgi Valley, India in the 90s. K. Paddayya on lower left.

After your PhD, what positions have you held and where?

Towards the end of my PhD in New Mexico, I applied for a postdoctoral fellowship with Rick Potts at the National Museum of Natural History in Washington, D.C. I landed the postdoc in 1987, and while this was only a one year fellowship, I have since been associated with the Smithsonian's Human Origins Program. The postdoc was a critical position for me, as had the opportunity to evaluate Bed I and II sites in Olduvai Gorge. It also allowed me to travel to India to conduct Palaeolithic archaeology over many years. At the same time, I became fascinated with the Palaeolithic collections, which were amassed since the 19th century, though poorly known to outsiders. Rick and I ended up writing a book on the history behind the Smithsonian's Palaeolithic collections (Petraglia and Potts, 2004). Alongside my research at the museum, I got involved in Cultural Resources Management work, mostly centred in eastern North America, though also involving national and international work. I eventually became the Manager of the Cultural Resources Program in the Parsons Corporation, overseeing large-scale archaeology projects, providing me with valuable administrative skills I use to this day.

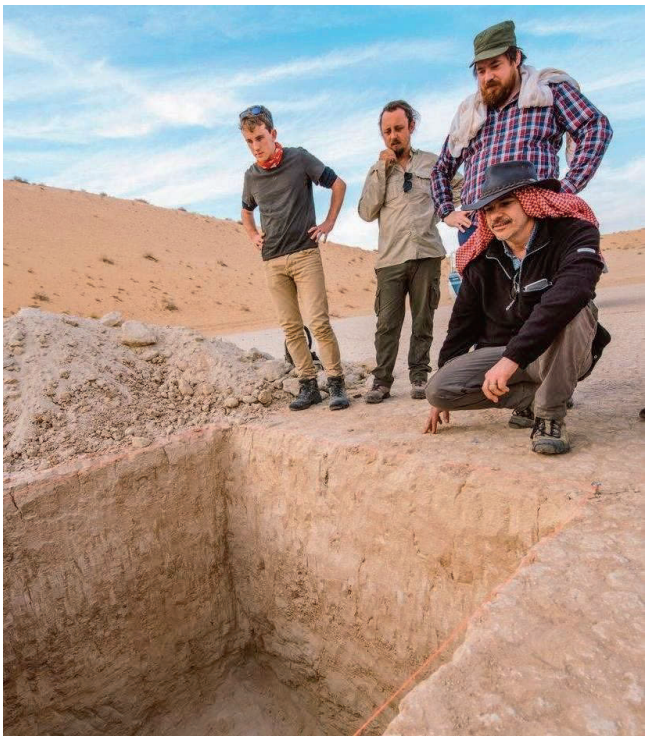
Though I was happily working in Washington, D.C. for 14 years, I felt the need to change direction, and teach. It was at this moment that an email from Rob Foley hit my inbox, advertising a Lecturership at the University of Cambridge. Soon after, I found myself as a Lecturer in the new Leverhulme Centre for Human Evolutionary Studies at Cambridge. The lectureship expanded my research horizons tremendously, as I designed courses which entailed teaching about hominin fossil record and genetics. As I was married to the archaeologist, Nicole Boivin, we were in search of a dual hire opportunity, which

eventually landed us in the School of Archaeology, University of Oxford. I took up the position of Co-Director of the new Oxford Centre for Asian Archaeology, Art, and Culture. Oxford exposed me to exemplary research in dating and environmental reconstruction, which I apply to my projects to this day.

While we were at Oxford, my wife Nicky was offered the post of Director of a new Department of Archaeology at the Max Planck Institute for the Science of Human History in Jena, Germany. We were offered an attractive dual hire package and so we took up our posts in 2016. We are currently based in Jena, where we engage with a vibrant community of archaeologists, including many interdisciplinary researchers from around the world.

What current projects are you working on? Where do you hope these go in the future?

The core of my work in the last 10 years has been in Saudi Arabia, a key geographic bridge between Africa and the rest of Eurasia. This has been a terrific project, and our team has made a number of key discoveries. This project is expanding in scope in recent years thanks to the leadership efforts of Dr. Huw Groucutt and Dr. Maria Guagnin, and we are now turning to cave sites and to early and middle Holocene sites, which will provide us with important new information on climate change, dispersals, and inter-regional connections.



Mike with team members in Saudi Arabia, pictured here are Dr. Huw Groucutt, Dr. Mathew Stewart, and Dr. Richard Clark-Wilson.

I have been working closely with members of the IVPP, Chinese Academy of Sciences on the Pleistocene record of Eastern Asia. Together with Dr. Shi-Xia Yang and colleagues, we have published on the famous Nihewan Basin sites and now we are turning our attention to the extraordinary Late Pleistocene record, which is so exciting given how little we know about the dispersal of *Homo sapiens* into the region (Yang *et al.,* 2019).

Our work at Panga ya Saidi in the coastal upland of Kenya has been wonderful (Shipton *et al.,* 2019), as the cave site has revealed an impressive Middle and Later Stone Age record extending over 80,000 years. The cave is in a tropical ecotone setting, which suggests it may have been a refuge during difficult times, and so in the next few years we will expand our investigations to better understand human adaptations through time.

Our work in Sri Lanka continues to draw my attention thanks to the talent of my PhD student, Oshan Wedage. Our work on cave sites, dating back to 45,000 years ago, has shown that modern humans were living in rainforests (Wedage *et al.,* 2019). We have now begun to excavate coastal sites, and this work is showing an even longer record of human occupation. In future years, we hope to conduct more field work, allowing us to compare and contrast rainforest and coastal records.

What has been your favourite memory from the field?

One of my favourite memories was when our team first visited the Jubbah oasis in Saudi Arabia. As soon as we began surveying, we found multiple, intact Middle Palaeolithic sites (Petraglia *et al.,* 2012). These were some of the first stratified and dated Palaeolithic sites found in Saudi Arabia and in association with an ancient lake. We were previously told there were no palaeolakes in Arabia, and now our satellite work estimates up to 10,000 palaeolakes and wetlands were present, many with fossils and archaeological finds.

What project or publication are you most proud of?

I am particularly proud of our article on the Toba volcanic super-eruption, published in *Science* (Petraglia *et al.,* 2007). This article set the tone for a number of debates that I am still involved in, including on the timing of out of Africa dispersals and the effect of the super-eruption on hominins and ecosystems.

What do you think has been the most revolutionary discovery in your field over the last 5 years?

Though not without controversy, I think the discovery of 3.3 million-year old tools in eastern Africa is incredibly exciting. Given my own interest in primate archaeology (Haslam *et al.,* 2009), tool use and the evolution of behaviour, I would think that we are still missing an archaeological record that may go back millions of years earlier than we currently realise.

What would you be if you were not an archaeologist?

I would likely be in a field having something to do with life on Earth. In high school and during my undergraduate years, I took a number of classes in marine biology and coastal palaeontology. Visits to ancient reefs, now in the forests of upstate New York, were mind-blowing experiences, and I continue to look back on these class trips with great fondness.

References:

Haslam, M., Hernandez-Aguilar, A., Ling, V., Carvalho, S., de la Torre, I., DeStefano, A., Du, A., Hardy, B., Harris, J., Marchant, L., Matsuzawa, T., McGrew, W., Mercarder, J., Mora, R., Petraglia, M., Roche, H., Visalberghi, E. and Warren, R. (2009). Primate archaeology. *Nature,* 460, pp. 339–344. DOI: 10.1038/nature08188.

Leakey, R. E. and Lewin, R. (1977). *Origins*. Penguin Books. ISBN: 9780525171942.

Petraglia, M. D., Akoshima, K. and Straus, L. G. (1994). Interpreting the Formation of the Abri Dufaure: An Upper Paleolithic Site in Southwestern France. *Journal of Anthropological Archaeology,* 13(2), pp. 139-151. DOI: 10.1006/jaar.1994.1009.

Petraglia, M. D., LaPorta, P. and Paddayya, K. (1999). The First Acheulian Quarry in India: Stone Tool Manufacture, Biface Morphology, and Behaviors. *Journal of Anthropological Research,* 55(1) DOI: 10.1086/jar.55.1.3630977.

Petraglia, M. D. and Potts, R. (2004). Old World and Paleolithic and the Development of a National Collection. *Smithsonian Contributions to Anthropology*. 1-48. DOI: 10.5479/si.00810223.48.1.

Petraglia, M. D., Korisettar, R., Boivin, N., Clarkson, C., Ditchfield, P., Jones, S., Koshy, J., Mirazon Lahr, M., Oppenheimer, C., Pyle, D., Roberts, R., Schwenninger, J., Arnold, L. and White, K. (2007). Middle Paleolithic Assemblages from the Indian Subcontinent Before and After the Toba Super-Eruption. Science, 217(5834), pp. 114-6. DOI: 10.1126/science.1141564.

Petraglia, M. D., Alsharekh, A., Breeze, P., Clarkson, C., Crassard, R., Drake, N. A., Groucutt, H. S., Jennings, R., Parker, A. G., Parton, A., Roberts, R. G., Shipton, C., Matheson, C., al-Omari, A. and Veall, M. (2012). Hominin Dispersal into the Nefud Desert and Middle Palaeolithic Settlement along the Jubbah Palaeolake, Northern Arabia. PLoS ONE, 7(11), e49840. DOI: 10.1371/journal.pone.0049840.

Shipton, C., Roberts, P., Archer, W., Armitage, S. J., Bita, C., Blinkhorn, J., Courtney-Mustaphi, C., Crowther, A., Curtis, R., d'Errico, F., Douka, K., Faulker, P., Groucutt, H. S., Helm, R., Herries, A. I. R., Jembe, S., Kourampas, N., Lee-Thorp, J., Marchant, R., Pitarch Marti, A., Prendergast, M. E., Rowson, B., Tengeza, R., White, T. S., Petraglia, M. D. and Boivin, N. (2018). 78,000-year-old record of Middle and Later Stone Age innovation in an East African tropical forest. *Nature Communication,* 9, pp. 1832. DOI: 10.1038/s41467-018-04057-3.

Wedage, O., Amano, N., Langley, M. C., Douka, K., Blinkhorn, J., Crowther, A., Deraniyagala, S., Kourampas, N., Simpson, I., Perera, N., Picin, A., Boivin, N., Petraglia, M. and Roberts, P. (2019). Specialized rainforest hunting by *Homo sapiens* ~45,000 years ago. *Nature Communication,* 10, 739. DOI: 10.1038/s41467-019-08623-1.

Yang, S., Deng, C., Zhu, R. and Petraglia, M. (2019). The Paleolithic in the Nihewan Basin, China: Evolutionary history of an Early to Late Pleistocene record in Eastern Asia. *Evolutionary Anthropology*, 29(3), pp. 125-142. DOI: 10.1002/evan.21813.

Dr Shi-Xia Yang[9]

Shi-Xia Yang is a Palaeolithic archaeologist from the Institute of Vertebrate Palaeontology and Palaeoanthropology of the Chinese Academy of Sciences. Her current research focuses on stone tool production techniques, raw material sourcing and human adaptation to different environments in East Asia. Recently, she was also granted a fellowship from the Alexander von Humboldt Foundation to conduct research at the Max Planck Institute for the Science of Human History between 2017 and 2019.

What are your research interests and your particular area of expertise?

Generally, I am interested in human evolution in relation to climate change. I am a Palaeolithic archaeologist, and I devote a lot of time to researching the evolution of human behaviour. Currently, my own research focuses on stone tools in Palaeolithic East Asia and understanding how climate change may have influenced stone tool production techniques, raw material sourcing and so on.

What originally drew you towards human evolution studies?

During my first two years at university, I was fascinated by the exquisite bronzes of Shang Dynasty (also named Yin Shang, the Chinese dynasty in the second millennium BC) and thought I would go on to study them. However, I changed my mind after my first field excavation in 2008 at the beginning of my third year of university, which is usually when students receive field training in China. We excavated a site containing cultural layers from historical periods to the Neolithic Age, but without any from the Palaeolithic. It was then that I began to get curious about what the Palaeolithic was like. To get more information about the Palaeolithic, I began to read more books about stone tools. I became deeply attracted to the different types of lithics and realised that Palaeolithic studies is closely related to geology, which was one of my favourite subjects in high school. In 2009, I got the chance to visit the Institute of Vertebrate Palaeontology and Palaeoanthropology (IVPP) of Chinese Academy of Sciences (CAS). This is an institute where a group of archaeologists focus mainly on Palaeolithic and have a large collection of lithics from different parts of China. In the following year, I entered IVPP as a PhD candidate for a five-year program.

What was your PhD topic? Where did you complete your PhD and who was your supervisor? How did you find your PhD experience?

I obtained my PhD at Institute of IVPP in April 2015. My PhD topic was on the Acheulean of the Dingcun site along Yellow River. I focussed on technique analysis and performed a knapping experimental study of the Dingcun assemblage.

At that time (2010-2012), the Acheulean in Eastern Asia was a controversial issue. Only a few scholars in China supported my work. My supervisor, Yamei Hou, and I felt huge pressure from other colleagues, but my supervisor really encouraged me to think and work independently. She also encouraged me to

[9] Institute of Vertebrate Palaeontology and Palaeoanthropology, Chinese Academy of Sciences, China; yangshixia@ivpp.ac.cn

do an exchange project with a French research team. During my PhD, with the support of the Sino-French Program Cai Yuanpei, I had the chance to work and study in France with Prof. Jacques Pelegrin and Jacques Jaubert. They helped me learn a lot about stone tool manufacturing techniques and how to conduct knapping experiments.

Finally, I published my papers on the Dingcun's Acheulean and finished my PhD (Yang *et al*., 2014; Yang *et al.,* 2016). My PhD was an important experience in learning how to break conventions and work hard on my own academic ideas.

After your PhD, what positions have you held and where?

After my PhD, I was still at the Chinese Academy of Sciences (CAS), however I moved to another institute, the Institute of Geology and Geophysics, and I began a post-doc research project within a geologic group. In those two years, I was the only archaeologist there, whilst others worked on chronology, geophysics, palaeoenvironments and geotectonics. It was a wonderful experience, as I learned how to work interdisciplinarily and made some excellent friends. After two years, in July of 2017, I returned to IVPP, CAS, and became a permanent member there. In the same year, I received a Humboldt fellowship and so I worked at the Max Planck Institute for the Science of Human History for two years till the end of 2019. Now I am back to China to continue my research work with the IVPP, CAS.

All of this has happened early in my academic career, during the first five years since I got my PhD. I feel very lucky to have been given the chance to work in different research institutions and learn from cooperative partners and enlightened supervisors working in different disciplines.

What current projects are you working on? Where do you hope these go in the future?

In the recent five years, I have been mainly working on a project titled: *"Behavioral Adaptations of the Earliest Humans in East Asia"*. I've been working on this project with Prof. Cheng-Long Deng (from the Institute of Geology and Geophysics, CAS) and Prof. Michael Petraglia (Max Planck Institute for the Science of Human History) to understand early human behaviour and environmental influences on human evolution in the well-known Nihewan Basin (Yang *et al.,* 2020a). We have been trying to explain more details of Early Pleistocene hominin behaviour in eastern Asia and link it to the changing climate in the region.

On the Losses Plateau, I have worked with Prof. Zhaoyu Zhu, Prof. Robin Dennell and Prof. Weiwen Huang. We recently reported the earliest appearance of hominins outside Africa at the site of Shangchen in *Nature* (Zhu *et al.,* 2018), and the oldest artefacts are dated to about 2.12 Ma

Currently, I am also working with Dr. Jianping Yue and Prof. Li Youqian on the project: *"The Environmental changes and behavioral adaptation of hunter-gather in Northeastern China."*. Northeast China is situated at the crossroads between North China, Mongolia, the Russian Far East, the Korean Peninsula and the Japanese archipelago, and the site is characterised by the high sensitivity to climatic fluctuations during the Late Pleistocene to early Holocene. It is a really great project!

I am looking forward to making more exciting archaeological findings and enriching the Palaeolithic story of eastern Asia. At the same time, I would love to know more about how humans will adapt to different environments in the future.

Shi-Xia taking part in field investigations in East Asia

What do you like the most about being in the field?

For me, field archaeology is a wonderful combination of manual and mental work, and it brings me closer to nature, which is important to me. My favourite memories from the field are always related to the beautiful sunset after a whole day's excavation.

What project or publication are you most proud of?

I am very proud of joining the team that led to the discovery of the earliest stone tools in eastern Asia (Zhu *et al.,* 2018). I would also say that the Loess-Paleosols sequence is amazing and looking for stone tools in the deepest section is one of the best things I have ever done.

What do you think has been the most revolutionary discovery in your field over the last 5 years?

Recently, with the development of ancient DNA techniques, I have seen a series of important publications which have really refreshed our knowledge of early humans. For example, the publication of the genome of the offspring of a Neanderthal mother and a Denisovan father deeply changed what we can know about extinct hominins - I think this is a really revolutionary discovery (Slon *et al.,* 2018).

What would you be if you were not an archaeologist?

When I was a teenager, my ideal career was to become a diplomat. After starting university, I found myself more inclined to work on something close to nature (plants or animals), so maybe a botanist!

During the 2018 field trip to the Loess Plateau

References:

Slon, V., Mafessoni, F., Vernot, B., de Filippo, C., Grote, S., Viola, B., Hajdinjak, M., Peyrégne, S., Nagel, S., Brown, S., Douka, K., Higham, T., Kozlikin, M. B., Skunkov, M. V., Derevianko, A. P., Kelso, J., Meyer, M., Prufer, K., and Paabo, S. (2018). The genome of the offspring of a Neanderthal mother and a Denisovan father. *Nature,* 561, pp. 113–116. DOI: 10.1038/s41586-018-0455-x.

Yang, S. X., Huang, W. W., Hou, Y. M., Yuan, B. Y. (2014). Is the Dingcun lithic assembly a "chopper-chopping tool industry", or "Late Acheulian"? *Quaternary International*, 321, pp. 3-11. DOI: 10.1016/j.quaint.2013.05.012.

Yang, S. X., Hou, Y. M. and Pelegrin, J. (2016). A Late Acheulean Culture on the Chinese Loess Plateau: The techno-economic behavior of the Dingcun lithic industry. *Quaternary International,* 400, pp. 73-85. DOI: 10.1016/j.quaint.2015.10.043.

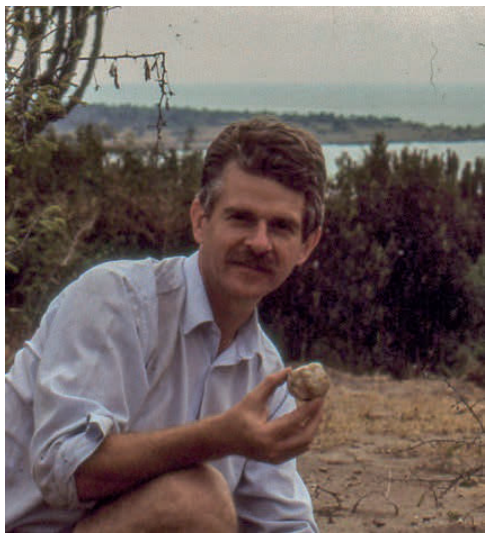
Yang, S. X., Deng, C., Zhu, R. and Petraglia, M. (2019). The Paleolithic in the Nihewan Basin, China: Evolutionary history of an Early to Late Pleistocene record in Eastern Asia. *Evolutionary Anthropology*, 29(3), pp. 125-142. DOI: 10.1002/evan.21813.

Yang, S. X., Wang, F. G., Yue, J. P., Deng, C. L., Zhu, R. and Petraglia, M. D. (2020) Technological innovations at the onset of the Mid-Pleistocene Climate Transition in high-latitude East Asia. *National Science Review*, nwaa053, DOI:10.1093/nsr/nwaa053.

Zhu, Z., Dennell, R., Huang, W., Wu, Y., Qiu, S., Yang, S. X., Rao, Z., Hou, Y. M., Xie, J., Han, J. and Ouyang, T. (2018). Hominin occupation of the Chinese Loess Plateau since about 2.1 million years ago. *Nature,* 559, pp. 608–612. DOI: 10.1038/s41586-018-0299-4.

Professor John Gowlett[10]

John Gowlett is a Palaeolithic Archaeologist and Paleoanthropologist at the University of Liverpool. He is a world leader in a number of areas of human evolution studies, such as the origins of fire use, the emergence of language and art and the evolution of early stone technologies. He has been involved with fieldwork projects in eastern Africa, such as that at the site of Kilombe in Kenya, as well as southern Africa. John was elected as a Fellow of the British Academy in 2017 in recognition of his work on the evolution of early human advanced capabilities, the origins and development of design form and proportion in artefacts and early hominin fire use. Recently, a number of colleagues came together from around the world to produce an edited volume titled 'Landscapes of Human Evolution: Contributions in Honour of John Gowlett', paying homage to his impressively extensive research profile (Cole *et al*., 2020).



Finding a Middle Stone Age core in Mweya, Uganda (1990).

What are your research interests and your particular area of expertise within archaeology?

I have always been interested in one major issue of evolution – how we became human. It always went beyond archaeology for me. My first book *Ascent to Civilization* was a shot at taking on the challenge, at a fairly popular level – it's very hard to keep that up alongside detailed research, but recently in *Thinking Big* working with good colleagues such as Clive Gamble and Robin Dunbar, that spread the load and made it easier. David Cannadine, the historian, has quoted the French scholar Le Roy Ladurie to the effect that we are all fundamentally parachutists or truffle hunters – looking at the world, or seeking for detail. In truth in archaeology we always need both, for ideas to be sustained by evidence. In detail, I know quite a bit about parts of the Acheulean handaxe tradition, and aspects of fire studies, but I'm constantly reminded of how much I don't know. I like to explore how early humans came to assemble and manage chains of ideas.

What first inspired your interest in anthropology and archaeology?

Like lots of us, I think, I started becoming interested in the past at an early age. My father used to take us around castles on summer holidays, especially in Wales. We also used to visit my grandmother in Essex, and alongside her house was a cart track. We used to hunt for fossils in the gravel – I still have a couple of beautiful sea urchins derived from the chalk. At nine a school prize had me taking a voucher to a bookshop -but my 5 shillings didn't extend to any of the books – finally there was a little book on fossils, which I still have – I didn't understand that you could make up the price - .the 7 shillings tag was a great concern. Somehow the 2 shillings were found!

By 12 or 13 I was going on bike rides and sketching old houses and churches, then came the first chance to work on an excavation – in Chester, on the Roman fortress ditch outside the city wall. Hugh Thompson provided a chance to work on the amphitheatre. My school thought that archaeology meant classics, but geology and art had more appeal for me – I managed an O-level in one and an A-level in the

[10] Department of Archaeology, Classics and Egyptology, University of Liverpool, UK; gowlett@liverpool.ac.uk

other. The great eye opener was the arrival of my university reading list - I was entranced with books such as Carter's *Human heredity* and Howells' *Mankind in the making.*

John (right) at East Turkana with (left to right) Kay Behrensemeyer, Jack Harris and Dinah Crader (1972). Jack Harris calls it 'the heroic age'.

What was your PhD topic and who was your supervisor at the University of Cambridge?

My dissertation was entitled rather prosaically 'A contribution to studies of the Acheulean in East Africa with especial reference to Kilombe and Kariandusi'. My main teacher was Charles McBurney; he had a great deal to offer, but because he could be rather austere, and seemed a bit of a traditionalist – which he wasn't - many students preferred to work with Eric Higgs, the inspirational leader of an early agriculture project which also swept in the Palaeolithic. I went with McBurney on an expedition to Afghanistan, but his idea for me to become 'our man in Central Asia' didn't fit with my great desire to work on earlier human origins. It was the flamboyant Pat Carter, on the fringes of the Cambridge department, but highly active in Africa, who made the connection that allowed me to have an early season with Glynn Isaac at East Rudolf, now East Turkana. Glynn made plain to me that far too many people wanted to work on the new Oldowan occurrences. BUT, a large new Acheulean site was coming up – and that was Kilombe. Kariandusi became tacked onto the thesis when Richard Leakey wanted to have the Kariandusi museum renovated, and the chance to work there was not to be missed. As McBurney was away in Russia, Alan Bilsborough the physical anthropologist stood in to be my supervisor, and has remained a friend and occasional mentor ever since. Apart from his support there seemed so little interest in Cambridge that I took an unusual opportunity – a lectureship in archaeology in Khartoum, Sudan, my first real job. I came back before my viva. Sadly, McBurney died the previous night. I can see much more clearly now than then his great sense of obligation to be rigorous in the face of the very limiting data that we get in the Palaeolithic.

Visiting Meroe in Sudan after a 4000-mile drive by landrover (1975).

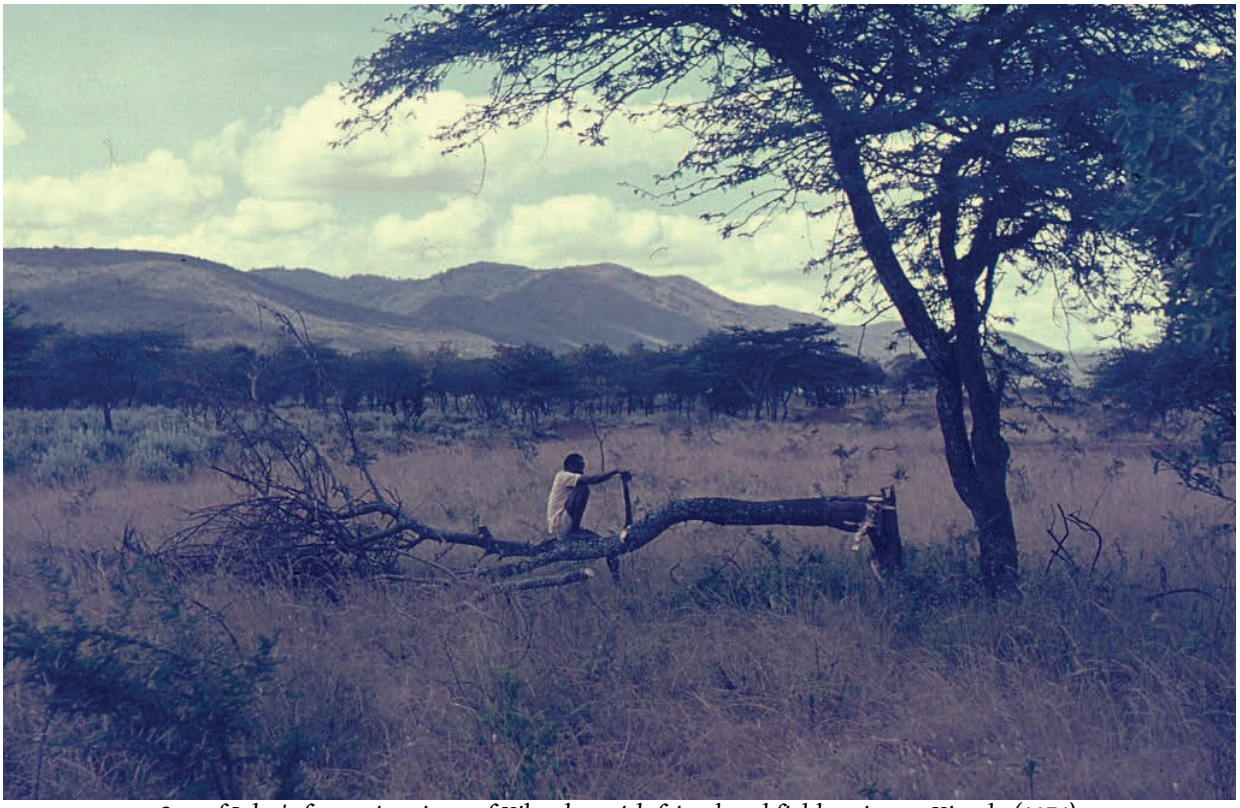
What were the main findings from your PhD?

My thesis set out the main finds of two big million-year-old Acheulean sites – early dates, and not always accepted, still less that such industries could have many advanced characters. Learning this directly from the material and its dynamics often put me at odds with received opinion. I was influenced by books such as Annett's *Feedback and human behaviour* and the work of the psychologist Kevin Connelly. My main conclusion was that we shouldn't underestimate early hominins – I came to appreciate that they have many abilities which some people would deny even in the Neanderthals! I was getting this into print before I finished the thesis, in a note in *Nature* about cultural complexity that Tom Wynn says was one of the first pieces on Palaeolithic cognitive archaeology - though his own work has a very strong claim.

What projects are you currently working on at the University of Liverpool and why are these important for understanding ancient hominins?

My field research is centred on the extinct volcano of Kilombe in Kenya, and the archaeological sites on its southern flanks and within its caldera. For a very long time I have been fascinated by the possibilities of what we call the Acheulean main site – strictly GqJh1. It is a vast handaxe distribution about a million years old. It gives a very unusual opportunity – the handaxes are coming out of a single horizon with outcrops up to 200 metres apart, so there is an almost unique chance to compare the different outputs made at almost the same moment in time.

The new project has taken us up to the heart of Kilombe mountain, its caldera, to much older sites. They are important for learning how early hominins exploited high level environments.



One of John's favourite views of Kilombe, with friend and field assistant Kimolo (1974).

What is your favourite thing about fieldwork and where has been your favourite place to excavate?

I have especially fond memories of working with Dr James Brink at Cornelia in the Free State of South Africa. It is another million-year-old handaxe site, with lots of fauna. You are right out on the high veld, astonishingly more like prairies of the American Midwest than the Africa which I knew. James would run a very friendly camp, working hard with his crew all day long then still insisting on cooking in the evening, great rows of steaks or the South African wors on the campfire, and we would sit out in the cold under the great African sky with its incomparable stars, with red wine and brandy. A great loss, James succumbed to a tumour a few months ago, and I've been working to help get one of his last papers to press.

Eastern Africa is so different, and my main joy for fieldwork: I love Africa, its people, its huge variety. My soul lifts when the plane lands in Nairobi, and I enjoy each step of dealing with the colleagues in the Museum, even the officials that we meet, visiting our British Institute in eastern Africa, then the long drive up to site in chaotic traffic; going up and down the volcano on a rock road each day, and especially meeting again and dealing with our farmer friends who are our helpers in the work. They

are far from well off, and have no more than primary education, but they have an interest, knowledge and focus which is humbling.

James Brink cooking steaks over the braai at Cornelia (2009).

What has been the highlight of your career so far?

The recent meeting which colleagues organised around my surprise festschrift is one of the most special things for me. They came together from all round the world, and I hope they are pleased with the result. It's a great privilege for me to go through it seeing all their different perspectives (Cole et al., 2020).

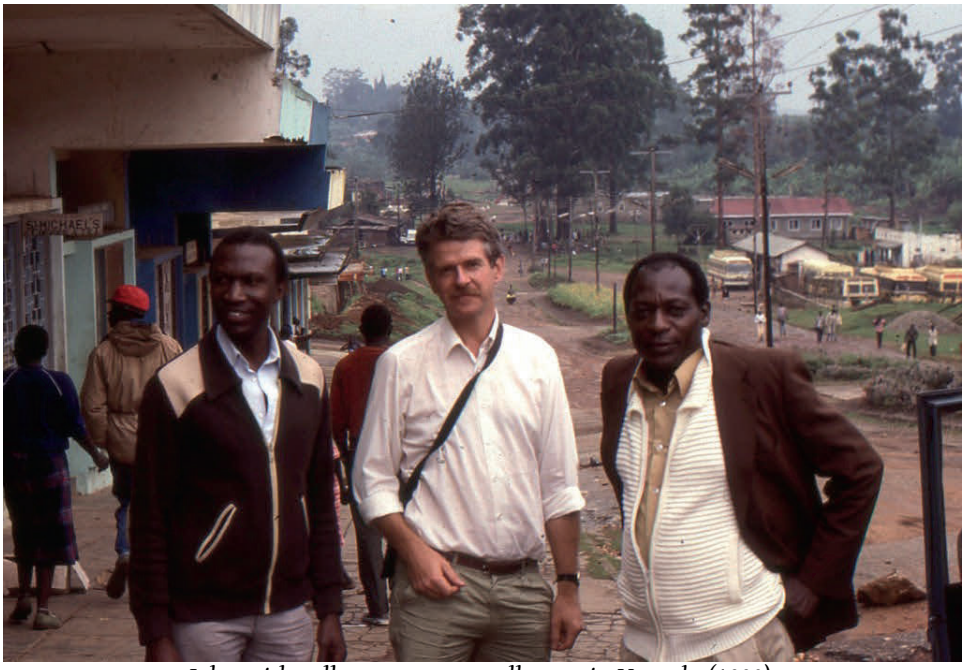
People often ask an archaeologist what the most exciting thing is you have ever found. Of course, we don't see things that way; there are moments all the same – and one of the most special things came working with Tony Buchner on a Palaeoindian site in Canada. At lunch break in the hot sun I was trailing my legs in the creek and paddling my hands in the water against the bank, when something just dropped into my palm – a perfect stone point pressure-flaked all over each face. They sent me a beautiful replica made by a local flint knapper. Finding australopithecine remains at Chesowanja was a stunning moment too – the actual finder was Bernard Ngeneo, who used to work with Richard Leakey.

We have to keep looking for highlights even in grim times. In January – it seems about 100 years ago – I spoke at an evolutionary biology conference in Ankara; that was a wonderful meeting organised by students of METU University to help protect evolution in the Turkish educational system. Speaking to an audience of 700 prospective students was thrilling. At dinner one student asked me what ten books had most influenced me – that was food for quite a lot of thought. In the end my list included only one archaeology book, Mary Leakey's Olduvai Gorge Volume 3.

John with Darwin and Australopithecus at METU in Ankara (January 2020).

What advice would you give to a first year PhD student at the start of their academic journey?

You need a lot of luck, as in Leakey's luck, but then at least to an extent you can make more luck. It helps to remember that a thesis is meant to be seen as a training in research and not supposed to be a huge mountain that takes over. If you can shape some papers and publish them early, that counts for a lot. And the essence of archaeology is that we don't know all the answers, so you have to enjoy not knowing everything!



John with colleagues at a small town in Uganda (1990).

My ten most influential books...

1. Forbes, Duncan. (1956). *British Fossils*. Second Edition. Black, London.
2. Homer. (600 BC?). *The Iliad*
3. Leakey, M.D. (1971). *Olduvai Gorge volume 3*. C.U.P. Cambridge.
4. Huxley, T.H. (1863). *Man's place in nature*. Macmillan, London.
5. Craik, Kenneth. (1943). *The nature of explanation*. C.U.P. Cambridge.
6. Huxley, J. (1974). *Evolution: the modern synthesis*. Third edition. Allen and Unwin, London.
7. Sacedoti, Earl D. (1977). *A structure for plans and behavior*. Elsevier, New York.
8. Eddington, A. (1939). *The philosophy of physical science*. C.U.P. Cambridge.
9. McGrew, W.C. (1992). *Chimpanzee material culture: implications for human evolution*. C.U.P. Cambridge.
10. Feynman, R. (1998). *Six easy pieces: the fundamentals of physics explained*. Penguin, London.

Acknowledgements:

There are others whom I would much like to mention. Early on Gerhard Bosinski welcomed me on his meticulous excavations at Feldkirchen-Gonnersdorf, where I also met Marcel Otte. Prof. Pierre Biberson started my affection for French archaeology by giving me free access to his Casablanca collections in Paris (Biberson, 1961). Bill Bishop, along with Willy Jones, explored the geology of the Baringo Basin, setting Kilombe on the scene – Maura Butler has lived there and helped us throughout the nearly fifty years. Bill's last big book (Bishop, 1978) includes my first publication. Glynn Isaac was then a major inspiration, and it was an honour to write the introduction to his papers, compiled by Barbara Isaac (Isaac, 1989). Mary Leakey, another great, wrote the foreword. J.D. Clark, who wrote an appreciation of Charles McBurney (Clark, 1986) included in his last massive volume on Kalambo Falls our paper in which Robin Crompton was a co-author. On a comparable scale are Naama Goren-Inbar's splendid volumes on Gesher Benot Ya'aqov, and the privilege fell to me in turn to write foreword to the last of these. Robert Hedges still deserves fuller credit for his work in launching AMS radiocarbon dating at Oxford, where we worked together for seven years (Hedges and Gowlett, 1986). Also, for seven years Clive Gamble and Robin Dunbar were stalwart colleagues in the British Academy's Lucy to Language project, which gave

rise to the latest cycle of work at Kilombe. James Brink was a greatly valued collaborator in that: his last paper on his enduring work at Cornelia will appear soon.

References:

Andrews, P. and Banham, P. (Eds) (1999). *Late Cenozoic environments and hominid evolution: a tribute to Bill Bishop*. Geological Society, London.

Biberson, P. (1961). *Le Paléolithique inférieur du Maroc atlantique*. Rabat, Publications du Service des Antiquités du Maroc, Fascicule 17.

Bishop, W.W. (Ed.) (1978). *Geological background to fossil man*. Edinburgh, Scottish Academic Press.
Bosinski, G. (2009). Les saïgas dans l'art magdalénien. *L'Anthropologie* 113(3):662-678.

Brink, J. S., Gowlett, J. A. J., Herries, A. I. R., Moggi-Cecchi, J., Hancox, J., Codron, D. and Rossouw, L. (in press). Cornelia-Uitzoek - its paleoecology, archaeology and geochronology. In Reynolds, S. (Ed.), *African Archaeological sites*. Cambridge, CUP.

Clark, J. D. and Wilkinson, L. P. (1986). Charles Brian Montagu McBurney (1914-1979): an appreciation. In Bailey, G.N. and Callow, P. (Eds), *Stone Age Prehistory*. Cambridge University Press. Cambridge, pp. 7-25.

Cole, J., McNabb, J., Grove, M., and Hosfield, R. (Eds.). 2020. *Landscapes of Human Evolution: Contributions in Honour of John Gowlett*. Summertown, Oxford: Archaeopress. DOI:10.2307/j.ctvx5w983.

Gamble, C., Gowlett, J. A. J. and Dunbar, R. (2014, 2018). *Thinking Big*. Thames and Hudson.

Hedges, R. E. M. and Gowlett, J. A. J. (1986). Radiocarbon dating by accelerator mass spectrometry. *Scientific American,* 254, 1, pp. 100-107.

Isaac, B. (Ed.) (1989). *The Archaeology of Human Origins: papers by Glynn Isaac*. Cambridge, C.U.P.

Sept, J. and Pilbeam, D. (Eds) (2011). *Casting the net wide*. Studies in honor of Glynn Isaac and his approach to human origins research. American School of Prehistoric Research Monograph Series, Peabody Museum, Harvard.

Professor Eleanor Scerri[11]

Eleanor Scerri is an archaeological scientist at the Max Planck Institute for the Science of Human History in Jena. She is the head of the 'Lise Meitner' Pan-African Evolution research group and is an affiliated associate professor at the University of Malta. She directs a suite of multidisciplinary projects and fieldwork programmes based in West Africa and the southern Mediterranean. Eleanor's research aims to understand the dynamics of human evolution and demography in different African regions and ecozones, from the Middle Pleistocene to the beginning of the Holocene. This interest also extends to Africa's surrounding regions, in southwest Asia, where she is a partner on ongoing research in the Arabian Peninsula, and the southern Mediterranean.

What are your research interests and your particular area of expertise?

At a broad level, I'm interested in where humans came from and how we got to this point. I'm particularly interested in the early periods of the prehistory of our own species, *Homo sapiens*, from earliest glimmerings up to the beginnings of settled societies who developed and practiced agriculture. How did the human story vary in rainforests and deserts, and from mainland regions to islands? How were humans actively altering their environments to suit their needs? How did these factors modulate the connections between the different populations, and perhaps even species, implicated in our evolution? I'm also really interested in developing methods to answer the sorts of questions we are interested in – methods that are capable of dealing with partial and often problematic archaeological data.

What originally drew you towards human evolution studies?

As a child I was given a book about prehistory, which had wonderful illustrations by the Czech artist, Zneděk Burian. I quickly became fascinated by the dioramas of what I perceived as very different past iterations of our world and wanted to understand the major differences between them, and how they formed. This interest came back to me as an undergraduate, after attending an optional module on Physical Anthropology at the University of Malta, where I was a student. I left the first lecture knowing that this was an area of science I had to pursue. The problem was that back in 90s Malta, we simply didn't have the teaching and learning resources for anybody to major in this area. With the support of my professors and almost all my extended family, I managed to visit the Natural History Museum in London, and studied collections there. The scientific staff in the Human Origins programme were wonderful. In the days before journals were online, they would take photocopies of journal papers and post them to me back in Malta to help, together with notes on why these papers were important. Apart from giving me the literature I needed to develop as a scholar, it really helped foster faith in myself. Back then Malta was still very much a developing country emerging from centuries of colonialism, and I form part of the first generation born in a fledgling, independent nation. For many, the effects of that recent past manifested itself as an intense lack of adequacy, impacting confidence and drive. The faith and help I received from leading international scholars during this formative period helped me to overcome that internalised colonialism. These sorts of actions from leading scholars remain critically

[11] Max Planck Institute for the Science of Human History, Jena, Germany; scerri@shh.mpg.de

important to ensure participation from young researchers coming from countries where – for a variety of reasons – opportunities for scholarship face significant barriers.

Eleanor (middle left) with her colleagues.

Where did you complete your PhD and what was your PhD topic? What were the findings from your PhD?

I completed my PhD at the University of Southampton in 2013. My doctoral research 'The Aterian and its place in the North African Middle Stone Age (MSA)' (Scerri, 2013), defined the diversity of Aterian 'tang' hafted Palaeolithic stone tool assemblages. Aterian assemblages are associated with some of the earliest examples of symbolically mediated culture, and several sites evidence the use of shell bead ornaments and bone tool industries. The Aterian is therefore thought to represent one of the first manifestations of identity and ethnicity. Although related factors such as subsistence strategies and social organisation are also reflected in the use and organisation of lithic technology, there have been few comparative technological studies of Aterian stone tools to support or refine hypotheses invoking identity. One of the most significant outcomes of my doctoral research was the recognition that the Aterian shares many key technological features with other, poorly defined, stone tool industries in the same spatiotemporal bracket. The similarities and differences did not correlate with the names of these assemblage groups, but rather with distance and the spatial organisation of palaeohydrological networks in that region and time frame. This suggested that while some groups of people became isolated by ecological bottlenecks, others used fluvial corridors to move around and connect with other groups. This demographic patchwork shaped the way groups of early humans interacted in North Africa between 145-70,000 years ago. The identification of aggregation sites indicates that some of these populations may have formed social networks.

After your PhD, where have you worked and in what positions?

After my PhD, I worked for 6 months on a short research contract at the University of Oxford working on the analysis of data for a paper that was subsequently published in *Journal of Human Evolution* (Scerri *et al.*, 2014). During this time, I learned I was successful in obtaining a Fondation Fyssen postdoctoral fellowship, hosted at the PACEA lab at the University of Bordeaux. While I was there, I worked on developing my experimental analytical approach to lithics more while setting up a new fieldwork project in Senegal. Following this position, I returned to Oxford with a British Academy Postdoctoral Fellowship. For this work, I primarily focused on the Middle Stone Age of North Africa and the Middle Palaeolithic of Arabia, but I also continued my pilot work in Senegal, conducting about three fieldwork seasons there during this time, as well as fieldwork in Arabia. I only stopped fieldwork to have my baby, but luckily I had a backlog of analyses to conduct then that meant I didn't have to travel. I was also fortunate to obtain a Marie Skłodowska Curie Actions (MCSA) Fellowship to follow straight on from my British Academy Fellowship. For the MCSA position, I moved to Germany, to the Max Planck Institute for the Science of Human History. This position was a bit of a departure from my previous work, because West Africa became the primary focus. I only held this position for seven months, because I was successful in obtaining my current position. However, that time was critical for pulling together a research network in West Africa and setting up joint investigations with partners in different West African countries, in regions of both rainforest and grassland.

Eleanor excavating in the field.

What current projects are you working at the Pan African Evolution Lab? Where do you hope these go in the future?

We have two main projects. The first is a fieldwork project across a West African transect, in regions of both rainforest and grassland. This has already generated data for palaeoenvironmental reconstruction,

a range of archaeological analyses and a range of biological analyses, including ancient DNA. We have some phenomenal sites to work on and we hope to be able to return to the field as soon as the global pandemic is brought under complete control. We also have modelling and simulation projects that we are using to test a range of scenarios about human evolution in Africa, some using data and others purely simulating data and then comparing generated patterns to the record. We hope to have papers with some initial results on both these projects this year. In addition to this, I am also conducting fieldwork and related analyses in Malta, where my career journey started. Here, we are focusing on reconstructing the quaternary palaeoecology of the islands and the effects of the first humans in these fragile ecosystems. There are a couple of new projects on the horizon too, one involving methods. That's all I can really say for now. We hope that these projects will soon yield important new insights on human evolution, and we're excited, even if we're not able to give much away yet!

Why is your work important for understanding hominin behaviour and evolution?

I think the main importance lies in trying to understand hominin behaviour and evolution from the perspective of regions that have historically been left off the human origins map, rather than continuing to extrapolate from the same, small, well-researched regions. Back when I started my PhD, nobody seemed to be very interested in North Africa or Arabia. However, these regions were geographically and culturally part of the world that I grew up in, and the issue was clearly one of a lack of research investment. Sure enough, our work in these areas helped to highlight how important they are for the human story. I think it's going to be the same with West Africa. Whenever we look in regions that have not been considered important or considered to have been 'empty' until relatively recently, we make discoveries that totally change our understanding of the deep past.

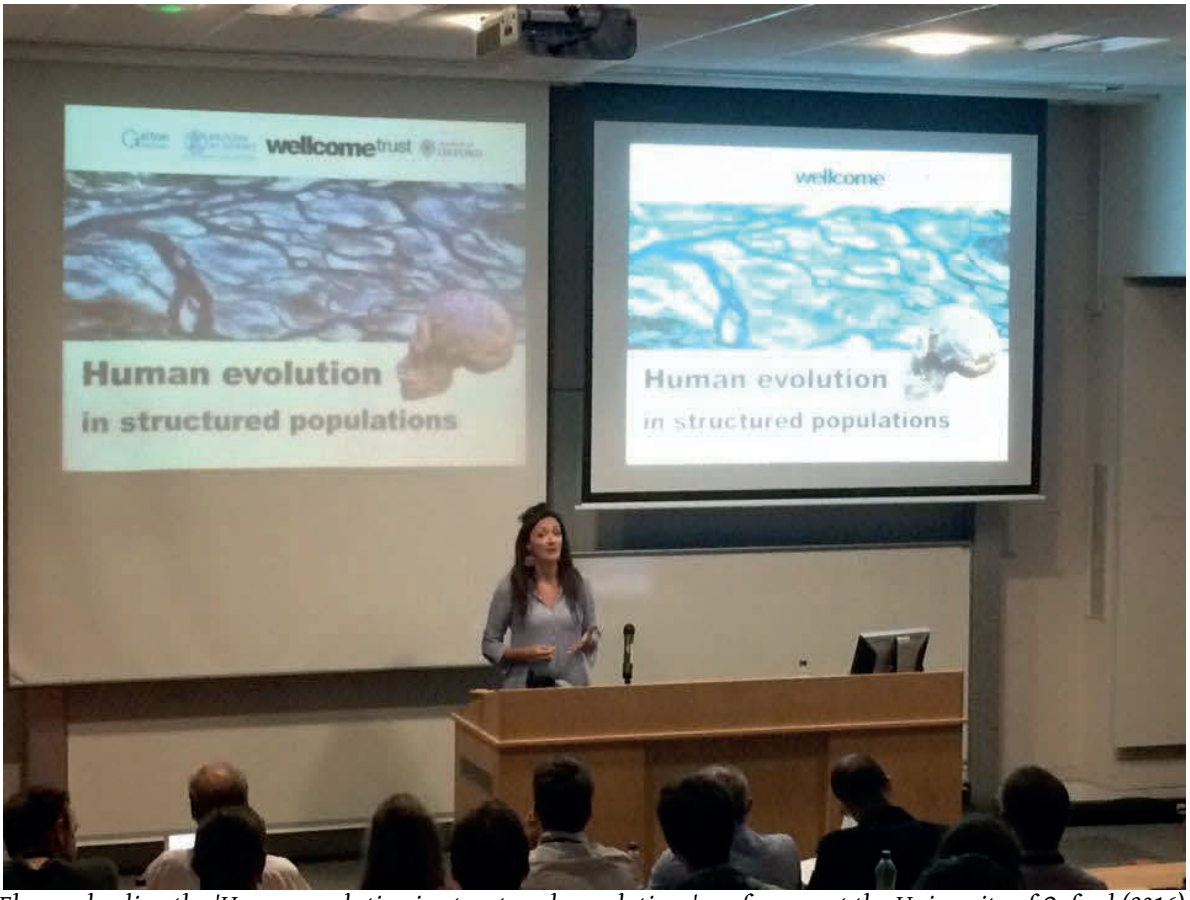
I also really believe that funding agencies should invest in projects aiming to develop new methods, not just 'discovery science'. I think the work we are doing in this area is important too. It takes time to develop new methods, but when they become available, they really underpin the ability to make new inferences and new discoveries from the wealth of data we already have

What do you think has been the most revolutionary discovery in your field over the last five years?

There have been many revolutionary discoveries and so I have to pick the ones that most affect the area that I am interested in. Finding extremely early *Homo sapiens* fossils at Jebel Irhoud in northwestern Morocco has to be up there for me (Hublin *et al*., 2017). I was also thrilled by our own discovery of the oldest directly dated *H. sapiens* fossils in Eurasia, east of the Levant, which was also the oldest human fossil to be discovered in Arabia (Groucutt *et al*., 2018).

What project or publication are you most proud of?

Probably our work on an African structured metapopulation model for human evolution (Scerri *et al*., 2018, 2019). It took a lot of patience and hard work across radically different fields of research, but it really demonstrated how communication and integration are key to advancing science. I have to give an honourable mention to our work in Senegal too, reporting the youngest Middle Stone Age dates in Africa - initial pointers to the emerging indications that the archaeological record here is different to other regions of the continent (Scerri *et al*., 2017; in press).



Eleanor leading the 'Human evolution in structured populations' conference at the University of Oxford (2016).

What advice would you give to a student interested in archaeology?

I would advise them to love quantification! No matter how fascinated we might be by certain questions, or how in love we are with certain artefacts or fossils, to really get answers and/or understand what they represent, we need to be capable of doing the analyses and understanding the results critically. It's amazing seeing quantaphobes turn into quantaphiles when they apply numbers and coding to something that interests them.

References:

Groucutt, H. S., Grun, R., Zalmout, I. A.S., Drake, N. A., Armitage, S. J., Candy, R., Clark-Wilson, R., Louys, J., Breeze, P. S., Duval, M., Buck, L. T., Kivell, T. L., Pomeroy, E., Stephens, N. B., Stock, J. T., Stewart, M., Price, G. J., Kinsley, L., Sung, w. W., Alsharekh, A., Al-Omari, A., Zahir, M., Memesh, A. M., Abdulshakoor, A. J., Al-Masari, A. M., Bahameem, A. A., Al Murayyi, K. M. S., Zahrani, B., Scerri, E. L. M. and Petraglia, M. D. (2018). *Homo sapiens* in Arabia by 85,000 years ago. *Nature: Ecology Evolution*, 2(5), pp. 800-809. DOI: 10.1038/s41559-018-0518-2.

Hublin, J. J., Ben-Ncer, A., Bailey, S. E., Freidline, S. E., Neubauer, S., Skinner, M. M., Bergmann, I., Le Cabec, A., Benazzi, S., Harvati, K. and Gunz, P. (2017). New fossils from Jebel Irhoud, Morocco and the pan-African origin of *Homo sapiens*. *Nature,* 546, pp. 289–292. DOI: 10.1038/nature22336.

Scerri, E. M. (2013). The Aterian and its place in the North African Middle Stone Age. *Quaternary International,* 300, pp. 111-130. DOI: 10.1016/j.quaint.2012.09.008.

Scerri, E. M., Groucutt, H. S., Jennings, R. P. and Petraglia, M. D. (2014). Unexpected technological heterogeneity in northern Arabia indicates complex Late Pleistocene demography at the gateway to Asia. *Journal of Human Evolution,* 75, pp. 125-142 DOI: 10.1016/j.jhevol.2014.07.002.

Scerri, E.M.L., Blinkhorn, J., Niang, K., Bateman, M. and Groucutt, H. S. (2017). Persistence of Middle Stone Age technology to the Pleistocene/Holocene transition supports a complex hominin evolutionary scenario in West Africa. *Journal of Archaeological Science Reports,* 11, pp. 639-646. DOI: 10.1016/j.jasrep.2017.01.003.

Scerri, E. M., Thomas, M. G., Manica, A., Gunz, P., Stock, J. T., Stringer, C., Grove, M., Groucutt, H. S., Timmermann, A., Rightmire, G. P., d'Errico, F., Tryon, C. A., Drake, N. A., Brooks, A. S., Dennell, R. W., Durbin, R., Henn, B. M., Lee-Thorp, J., deMenocal, P., Petraglia, M. D., Thompson, J. C., Scally, A. and Chikhi, L. (2018). Did our species evolve in subdivided populations across Africa, and why does it matter? *Trends in Ecology and Evolution,* 33(8), pp. 582-594. DOI: 10.1016/j.tree.2018.05.005.

Scerri, E. M., Chikhi, L. and Thomas, M. G. (2019). Beyond multiregional and simple out-of-Africa models of human evolution. *Nature Ecology and Evolution,* 3, pp. 1370-1372. DOI: 10.1038/s41559-019-0992-1.

Dr Rob Davies[12]

Rob Davis a Palaeolithic archaeologist who currently works at the British Museum in London. Rob is project curator for the 'Pathways to Ancient Britain' (PAB) Project, with his primary research interests lying in the Lower and Middle Palaeolithic record of northern Europe. He has also worked on the Arts and Humanities Research Council-Funded 'Fragmented Heritage' project at the University of Bradford and the Leverhulme-Trust funded 'Breckland Palaeolithic Project' at Queen Mary University of London. Rob is co-director of the Barnham Palaeolithic Field School in Suffolk and chair of the Lithic Studies Society.

What are your current research interests and particular area of expertise within archaeology?

Currently, my research is focussed on the Lower Palaeolithic of Europe, in particular that of northwestern Europe. I'm interested in understanding how humans were able to overcome the difficulties of occupying northern latitudes; how were they coping with these cooler climates with longer, colder winters and shorter growing seasons, and what new technologies or behaviours they needed to do this. In my current work I'm trying to work out when humans were in northern Europe and how they were managing to live in these new, unfamiliar landscapes.

In terms of my area of expertise within archaeology, I work primarily within the Lower Palaeolithic with a practical focus on lithic technologies. My specialities lie in lithic analysis, excavation, both geological and archaeological, GIS and survey techniques.

What originally drew you towards Palaeolithic archaeology?

When I started my undergrad, I was very much interested in later prehistoric periods. I don't think I had really been exposed to Palaeolithic archaeology at school or even on TV or anything like that. I was always interested in history and archaeology, in periods like the Neolithic and the Iron and Bronze Age. However, I had two excellent lecturers when I started my undergrad in archaeology at UCL, Ignacio de la Torre and Dietrich Stout, who were just amazing and had a big influence on me. They ran the Palaeolithic modules and I ended up taking them all. I found that over the course of my undergrad my interests shifted earlier and earlier in time! I went on to the MSc in Palaeoanthropology and Palaeolithic Archaeology at UCL, decided to do my masters dissertation on a Lower Palaeolithic assemblage with Nick Ashton at the British Museum and it all went from there. Once I had been exposed to the Palaeolithic, it felt like this was where all the really big unanswered questions were about human evolution and the development of modern human cognition, behaviour and culture, and I was hooked!

[12] The British Museum, London, UK; rdavis@britishmuseum.org

What path did you take to get to the position you're in now?

I came as a mature student to archaeology; I initially had a career in construction management as a site engineer. When I was 25, I quit that job and went back to university to study archaeology. I found that my previous career was actually very useful to my studies as I already had a lot of survey skills, which meant I was able to get involved in some really interesting projects right from the off. That was very useful.

I did my undergrad pre the huge increases in fees, so I was also able to go on and do my masters at UCL self-funded, which was good. The best decision I made, which was kind of fortuitous, was that I studied a collection from Hoxne, a Lower Palaeolithic site held at the British Museum, for my masters' project. I found it really useful to do a dissertation based around studying a collection and learning how to record and interpret an archaeological assemblage. Doing my own research on a collection definitely provided me with important skills going forward into a PhD. My PhD was at the University of Reading with Rob Hosfield and was on the Lower and Middle Palaeolithic from the River Solent, studying the river terraces that you find around Bournemouth and Southampton. Again, this project was very practical-based, with small-scale excavations, geophysical survey and OSL dating, plus I studied lots of collections, which gave me further research skills to go on into similar post-doc roles.

After my PhD, I was fortunate enough to get a two-year position at the University of Bradford on the 'Fragmented Heritage Project'. I was working on the part of the project that was working towards developing automated refitting technology. Part of my job was to produce the 3D digital models of artefacts which my colleagues used to develop algorithms that could identify refitting surfaces. I also worked on a new refitting study of the Boxgrove GTP17 lithic assemblage (Pope *et al*,. 2020). That was a good project. Then, I worked with Nick Ashton and Simon Lewis to write a proposal for the 'Brecklands Palaeolithic Project' which ended up being a three-year Leverhulme Trust funded project at the Queen Mary's University in London. And now I am currently working on PAB at the British Museum.

What are the aims, findings so far and future directions of this project?

With PAB (https://www.pabproject.org/), we're looking at the British Palaeolithic and trying to put it into context of the broader European Record, with a specific focus on three phases or chronological periods. We've called these Pioneering Populations (1 MA to 500 ka), Successful Colonisers (500 ka to 300 ka) and Emerging Neanderthals (240 ka to 40 ka). I work on the first two of these. At sites like Happisburgh and Pakefield, we see glimpses of human populations living in Britain from around 900 ka. So, in this part of the project we're trying to understand how these pioneering populations were adapting to their new environments. We think this could be *Homo antecessor*, as we see this species in Spain at a similar time, but at the moment we have no fossils in Britain from this period so it's hard to ascertain exactly who these earliest human groups were! In the second period, from around half a million years ago, we start to see evidence for much larger populations. We have a lot more sites and a lot more artefacts, which suggest that we have more sustained occupations, so we're looking to see what changes in behaviour and technology enabled humans to occupy these areas more successfully and for longer periods of time.

Finally, the work on the Middle Palaeolithic is being undertaken by a different team. This is mainly focussed on Jersey, looking at sites like La Cotte de St Brelade and the new site at Petit Portelet and providing new insights into Neanderthal behaviour and landscape use (Scott and Shaw, 2021).

So, they're the three big chronological periods we're currently focussing on in the project. In terms of future directions, we're going to continue working on those three periods. We're becoming increasingly interested in early fire use, as this may have been a necessary technology that allowed early humans to thrive in more northern latitudes. Around 400 ka is a really interesting period for fire-use; we start to see good evidence at sites like Beeches Pit but it remains a really patchy record. Is this due to preservation? Or was fire used in parts of the landscape that our sites are missing? Or was it yet to become a habitual technology used by all human groups? Sites like Beeches Pit and Barnham in East Anglia may help us start to answer these questions, so we'll be working with fire specialists such as John Gowlett and Sally Hoare, who are working on Beeches Pit, to try and better understand human fire-use during the Hoxnian Interglacial.

What is it like working as a researcher for a museum as opposed to a university? And do you prefer it?

I have been working with the same team of people whilst working on projects at universities and for the British Museum so, from my personal experience, there has not really been a huge change. However, I have found that there is definitely a change in emphasis in terms of the type of research that you do at a museum compared to a university. When you're employed by a university, you're looking to provide the best learning experience for your students at the same time as conducting internationally recognised research. At the museum, we're instead looking to provide the best learning experience for our visitors, which is very different to that which is provided for students. Whilst there's also an emphasis on international renowned high-quality research at the British Museum, this research is very much focussed on the collections that we have and bringing these collections to life to provide that learning experience for our visitors. Public engagement is of course important for any researcher, but there is definitely a different emphasis on it when you're working at a museum.

From a more practical point of view, when working at a university, you are part of a huge interdisciplinary institution, so you have more access to different equipment, software and journal access. You get less of that at a museum because the research is much more narrowly focussed. In terms of preference, it's hard to pick one over the other. I don't have any student teaching opportunities now, which I did when I was employed by a university, so I do miss that. But I enjoy working with collections as it's really interesting and there's the potential for developing small exhibitions.

You're also co-director of the Barnham Palaeolithic Field School. What is the field school, who is it aimed at and what's your most memorable/favourite moment from last season?

Our field school is funded by the 'Pathways to Ancient Britain Project' and it's been running since 2013. It initially started out as a field school for students from Leiden University in the Netherlands, as there had previously been a field school in Happisburgh for those students and this was the next project for them to work on. Over the next couple of years, we decided to broaden it out and so we opened it up to students from anywhere.

A few years ago, we started offering scholarships for students, so it doesn't cost them anything to participate. We provide them with a practical and accessible training experience, which is something that I didn't have when I was doing my studies, as there were no British-based Palaeolithic field school opportunities. Our field school is for students looking to continue their studies in a Palaeolithic-related discipline and would like to gain experience of Palaeolithic Quaternary geology field techniques. At the same time as being a great opportunity for students, it's very much a research excavation so we're trying to ask these same big questions about early humans during the Lower Palaeolithic. We've found

that there's two different assemblages at the site with considerable differences so we're trying to understand the relationship between those assemblages, and we have evidence for burning so we're also trying to understand whether that's related to human use of fire or natural fire. Also, there's a very rich environmental record at Barnham so we're using the data we get from there to reconstruct the environment for the Hoxnian interglacial period. So, we're looking to provide both a good teaching experience whilst also answering essential research questions about the Lower Palaeolithic.

In terms of the most memorable moment, we have reinterpreted the site since starting the new field school. As I mentioned, this is primarily because there are two different assemblages, one with hand axes and one without, which we had previously thought were the same age. This had been interpreted as the same population doing different things in different functional areas. However, when we opened a new area, we found that these two assemblages were stratigraphically separated, which we think shows the presence of two different groups of humans at the site (Ashton et al., 2016). So we see an initial group that did not make hand axes and then a second group, arriving not long after, that did make hand axes. This is very rare to find at the same site. These groups might be separated only by a few hundred years, perhaps only a few generations, and this level of chronological resolution is almost unheard of in Lower Palaeolithic archaeology. That's been really important for the way we've been thinking about the European Lower Palaeolithic record in the last couple of years (e.g. Ashton, 2018; Davis and Ashton, 2019).

Excavation of Area III, also known as the faunal area, from the last field school (2019).

What is your favourite thing about being an academia and what's one thing about academia that you would change?

The best thing has to be the freedom to be able to follow interesting avenues of research. Whilst our current project has clear aims, we do have the ability to follow it wherever it takes us which is really nice. From a personal point of view, I love fieldwork and so the opportunity to find and dig new sites is really exciting. The drawback is, of course, that it would be nice to have more jobs and more job security. We all work very hard and it takes up a lot of time, so it can get very stressful and there's a lot of pressure to publish and produce new results. All of this plus the precarious position a lot of people are in, as they are on short-term contracts, can make it difficult. I have been very lucky as I'm now in my third position, but there's always that end date looming. Saying that, I love what I do so I don't think people should feel too sorry for me!

References:

Ashton, N.M., (2018). Landscapes of habit and persistent places during MIS 11 in Europe A return journey from Britain. In Pope, M, McNabb, J., Gamble C.B. (Eds.), *Crossing the Human Threshold. Dynamic Transformation and Persistent Places during the Middle Pleistocene*. Routledge, London, pp. 142-164. ISBN 9780367878474.

Ashton, N. M., Lewis, S. G., Parfitt, S. A., Davis, R. J. and Stringer, C. (2016). Handaxe and non-handaxe assemblages during Marine Isotope Stage 11 in northern Europe: Recent investigations at Barnham, Suffolk, UK. *Journal of Quaternary Science,* 31, pp. 837-843. DOI: 10.1002/jqs.2918.

Davis, R. J. and Ashton, N. M. (2019). Landscapes, environments and societies: The development of culture in Lower Palaeolithic Europe. *Journal of Anthropological Archaeology*, 56. DOI: 10.1016/j.jaa.2019.101107.

Pope, M., Parfitt, S. A. and Roberts, M. B. (2020). *The Horse Butchery Site: A high resolution record of Lower Palaeolithic hominin behaviour at Boxgrove, UK*. SpoilHeap Publications, London.

Scott, B. and Shaw, A. (Eds.), (2021). *Repeopling La Manche: New Perspectives on Neanderthal Lifeways from La Cotte de St Brelade.* Prehistoric Society Research Papers No. 10. Oxbow Books, Oxford.

Part 3: Biological Anthropology and Palaeoanthropology

Dr Emma Pomeroy[13]

Dr Emma Pomeroy is a biological anthropologist and osteoarchaeologist at the University of Cambridge. She currently holds a lectureship in the Department of Archaeology in the Evolution of Health, Diet and Disease. Her research considers how both past and present variation in human health, growth and morphology is shaped by evolutionary processes and interactions with natural and social environments. Since 2016, Emma have also been the paleoanthropologist at renewed excavations at Shanidar Cave, Iraqi Kurdistan. Previously, Emma has also held a Junior Research Fellowship at Newnham College, Cambridge, as well as a Leverhulme Trust Early Career Fellowship at Liverpool John Moores University, where she lectured in Biological Anthropology.

Emma excavating Shanidar Cave. Photo by Graeme Barker

What are your research interests and your particular area of expertise?

I am a biological anthropologist who trained in human osteoarchaeology (the study of human skeletal remains from archaeological sites), but my research interests span work with contemporary populations, archaeological remains and our fossil relatives. What really fascinates me is how our bodies are shaped by our evolutionary past and the social, cultural and natural environments we live in, and so how we can learn about our past through studying the skeleton, as well as how our evolutionary history affects health and quality of life today. The potential for gaining new insights into life in past populations by studying the drivers of variation in living populations, and equally studying past populations to better understand our modern health challenges, particularly excites me.

What originally drew you towards human evolution studies?

I was interested in the past from a very young age, and especially bones and skeletons. One of my favourite toys at primary school was a rubber skeleton (which is sitting on my desk right now) and my parents say I used to go and look for bones in the garden. I grew up near Canterbury in Kent which has fabulous medieval city walls, a ruined castle, beautiful cathedral and ancient churches, as well as Roman remains beneath the city which really captured my imagination. I was fascinated by how people lived in the past, and what they were like. As an undergraduate I planned to study Archaeology, but got introduced to Biological Anthropology. Reading books in preparation for my admissions interview (I particularly remember Rob Foley's 'Another Unique Species') opened up a whole new world I had barely heard about – human evolution. My fascination grew through my undergraduate course and I was drawn into Biological Anthropology. My interests broadened into understanding human variation in the past and present in light of our evolutionary heritage and how our biology interacts with our environment to generate the huge diversity we see in humans, past and present.

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[13] Department of Archaeology, University of Cambridge, UK; eep23@cam.ac.uk

What was your PhD topic? How did you choose this and who was your supervisor?

My full PhD title was 'The Bioarchaeology of Adaptation to Andean Environments: A combined osteometric and anthropometric approach'. I wanted to understand how humans have adapted to the incredible, varied, and challenging environments of the South American Andes, and how biological and cultural adaptations interact and change across space and time. Originally, it was going to be an osteoarchaeological study, but as is so often the case with research there were unexpected challenges which disrupted my original plans, but also unexpected opportunities, which I grabbed and ran with. These opportunities saw me working with contemporary populations in Peru to understand the impact of the environment on morphology as a way of giving more insight into the causes of skeletal variation in the past. I studied with Jay Stock at Cambridge (now Professor at the University of Western Ontario, Canada), and through Jay came to work with Professor Jonathan Wells at UCL during my PhD as well. They were the best supervisors I could have hoped for – immensely supportive and generous with their time and advice, and constantly challenging me to explore new ideas, learn new methods, and push myself beyond what I thought I could do. I still work with them a lot now, and still learn from them constantly!

Emma conducting lab work in Argentina (2007)

What current projects are you working on at the University of Cambridge and where do you hope these go in the future?

One of the major projects I am currently involved in is the Shanidar Cave Project led by Professor Graeme Barker, which is conducting new excavations at this famous Neanderthal site in collaboration

with the Kurdistan Regional Directorate of Antiquities. Although the project was never intended to find new Neanderthal remains, I was asked to get involved when some Neanderthal bones unexpectedly came to light. Over the last couple of years we have been working to recover remarkable new articulated Neanderthal remains (Pomeroy *et al*., 2020a) found right next to the famous 'Flower Burial' discovered by Ralph Solecki's team in 1960. This discovery is a rare opportunity to tackle questions around how Neanderthals treated their dead, whether this had a symbolic or ritual component, and how this varied over space and time (Pomeroy *et al*. 2020b), using an array of modern archaeological techniques (e.g., soil micromorphology, pollen and starch analysis, eDNA). There is also great potential for various analyses of the skeleton itself, including aDNA, diet and origins through stable isotopes and calculus, and assessments of age at death, health status and morphology etc. With my colleague Dr Lucy Farr, I have also been working on Ralph Solecki's Shanidar Cave archive at the Smithsonian Institution to revisit some of the original evidence, interpretations and debates concerning the site. All in all, I hope that the Shanidar Cave Project, through making use of new and archive data, will help advance our understanding of our close evolutionary relatives in multiple ways, and add to the already major contributions that have emerged from discoveries at this site.

Excavating Shanidar 5. Photo by Graeme Barker.

I recently completed some work on the evolutionary origins of low lean mass (organ and muscle mass) in contemporary South Asian populations. Part of this project involved finding ways to estimate lean tissue and body composition from the skeleton (Pomeroy *et al*., 2018). We were able to estimate lean mass fairly reliably, but markers of body fat and obesity in the skeleton are far less reliable. So, one of the things I am starting to work on now, with colleagues from Cambridge, is how we might be able to identify body fatness more reliably from the skeleton. People often assume that most people in the past

were much more active and had a poorer diet than we do today so would rarely have become fatter or obese, but various lines of evidence, such as depictions of very curvaceous women in the European Upper Palaeolithic (think of the famous Venus of WIllendorf) suggest this may not have been the case. It would be really exciting if we could study body fatness in the past, as this would enable us to investigate a whole range of questions around the evolution of human body composition (even the leanest humans have high body fat compared with our closest great ape relatives), the impacts of dietary change on body composition, and give us new insights into health in the past and the present.

I would also love to go back to working in the Andes at some point – it's such an amazing part of the world and fascinating from the point of view of human variation and adaptation.

Does your research have any implications outside of academia?

I think trying to understand how we came to be who and what we are as a species is something that has wide popular appeal. I also believe learning about the incredible human variation we see around us and yet appreciating all the things that unite us as well has immensely important implications for how we live our lives. More practically, our evolutionary history can have important implications for our health and lives today, and that is something that interests me greatly. So, for example, our recent work which investigated the evolutionary origins of low lean tissue among contemporary South Asian populations (Pomeroy *et al.*, 2019). Low lean mass is implicated in the elevated susceptibility to non-communicable diseases such as Type 2 diabetes experienced by people with South Asian ancestry today, and non-communicable diseases have become one of the biggest health burdens and killers in the modern world, so understanding what influences disease susceptibility is very important. We looked at long term trends in South Asian lean mass using the archaeological skeletal record, and were able to show low lean mass has probably characterised these populations for at least 11,000 years. Therefore it's unlikely to change greatly in coming generations, and so planning treatments and prevention for non-communicable diseases in South Asian populations will need to take this into account.

Emma working with Dr Veena Mushrif at Deccan College (Pune, India)

What project or publication are you most proud of?

That's so hard to answer, I have been incredibly lucky to be involved in a number of fantastic projects and work with brilliant people. The Shanidar Cave Project is yielding such exciting finds and results, and it's an incredible privilege to follow on from the work of greats like Ralph Solecki, T. Dale Stewart and Erik Trinkaus, and to work with the brilliant current team led by Professor Graeme Barker in collaboration with Kurdistan Directorate of Antiquities. I am still very proud of some of my PhD work on limb proportions as a marker of early life environment: the data were very hard earned but showed really interesting patterns in how different parts of the body are affected by environmental challenges, and what this might tell us about the mechanisms underlying trade-offs in growth and health. I was also really proud of the work we did on the origins of low lean mass among contemporary people of South Asian ancestry, which is implicated in their elevated susceptibility to chronic conditions. As I said, using the archaeological record, we were able to show this was a characteristic dating back at least 11,000 years in South Asia, despite the challenges of small numbers of archaeological skeletons available to study (warm and wet conditions, as South Asia widely has, are not great for preserving bone) and inferring soft tissue characteristics from the skeleton.

Sorry, that's 3, which is cheating...

What do you think has been the most revolutionary discovery in your field over the last 5 years?

Another hard question! One thing I love about human evolutionary studies is that it's such a dynamic field, with major discoveries and new twists and turns in the human story happening all the time. The discovery of new species, both through fossils (such as *Homo luzonensis*, *Homo naledi*) and DNA (those elusive 'ghost species') is fleshing out our family tree to an extent we hadn't anticipated and is fundamentally reshaping our picture of how humans evolved.

What advice would you give to a student interested in your field of research?

Do what you love, go in with your eyes open, and make the most of every opportunity. Academia is not an easy place to find long term, secure employment, and there are many more highly qualified researchers than there are long term jobs. Part of it comes down to luck, and the right job coming up at the right time. But I always took the view that even if I didn't settle in academia long-term, I loved research and fieldwork, and would never regret the time I spent studying and in the field. So grab the opportunities that come up, and don't be afraid to branch out and step out of your comfort zone – you never know where those opportunities will take you and some of the work I have found most exciting and productive is where I took those unexpected opportunities and ran with them. Above all, make the most of time doing what you really enjoy.

If you weren't a biological anthropologist, what career would you pursue and why?

If I wasn't in academia, I think I would love to be a vet (though not sure I have the stomach and natural skill for it!). I think I would have liked to be a hill shepherd and sometimes dream of doing it when I retire (if I am still fit enough!). I love being outdoors and with animals, and although I know shepherding or veterinary practice is not an easy life, the chance to be outside and working with animals appeals hugely. Plus, it would also be a great excuse to observe and think about the natural world, and how different organisms have and continue to adapt to their environments. If I were to still be an academia, I have always been excited by paleontology and enjoyed chemistry...so who knows!

References:

Pomeroy, E., Macintosh, A., Wells, J. C. K., Cole, T. J. and Stock, J. T. (2018). Relationship between body mass, lean mass, fat mass, and limb bone cross-sectional geometry: Implications for estimating body mass and physique from the skeleton. *American Journal of Physical Anthropology*, 166, pp. 56– 69. DOI: 10.1002/ajpa.23398.

Pomeroy, E., Mushrif-Tripathy, V., Cole, T.J., Wells, J. C. K. and Stock, J. T. (2019). Ancient origins of low lean mass among South Asians and implications for modern type 2 diabetes susceptibility. *Scientific Reports*, 9, 10515. DOI: 10.1038/s41598-019-46960-9.

Pomeroy, E., Bennett, P., Hunt, C. O. Reynolds, T., Farr, L., Frouin, M., Holman, J., Lane, R., French, C., and Barker, G. (2020a). New Neanderthal remains associated with the 'flower burial' at Shanidar Cave. *Antiquity*, 94(373), pp. 11-26. DOI: 10.15184/aqy.2019.207.

Pomeroy, E., Hunt, C. O., Reynolds, T., Abdulmutalb, D., Asouti, E., Bennett, P., Bosch, M., Burke, A., Farr, L., Foley, R., French, C., Frumkin, A., Goldberg, P., Hill, E., Kabukcu, C., Mirazón Lahr, M., Lane, R., Marean, C., Maureille, B., Mutri, G., Miller, C.E., Mustafa, K., Nymark, A., Pettitt, P., Sala, N., Sandgathe, D., Stringer, C., Tilby, E., and Barker, G. (2020b). Issues of theory and method in the analysis of Paleolithic mortuary behavior: a view from Shanidar Cave. *Evolutionary Anthropology,* 29(5), pp. 263-279. DOI: 10.1002/evan.21854.

Professor Chris Stringer[14]

Chris Stringer is a physical anthropologist and a Research Leader in Human Origins at the Natural History Museum in London. Chris is one of the leading proponents of the 'Out of Africa' or 'Recent African Origins' hypothesis, which is currently the most widely accepted model for the origin of our species (Stringer and Andrews, 1988). He has excavated at sites in Britain and abroad, and currently is co-director of the Pathways to Ancient Britain project, working alongside Dr Rob Davis from the British Museum (this vol). Chris has published extensively in academic journals and has written numerous books, such as 'The Origin of Our Species' (Stringer, 2011) and 'Our Human Story' (Humphrey and Stringer, 2018).

What are your research interests and your particular area of expertise?

My interests now are focussed on reconstructing the last half million years or so of human evolution, collaborating with a range of colleagues in palaeoanthropology, archaeology, genetics, geochronology and paleoclimates. I've also been particularly involved with the British part of the story over the last 20 years or so, first of all directing the Leverhulme-funded Ancient Human Occupation of Britain projects, and then co-directing the Calleva Foundation-funded Pathways to Ancient Britain projects, with Nick Ashton at the BM. These latter projects came out of a long-term interest in the British Quaternary, fuelled by fieldwork with people like Tony Sutcliffe, Andy Currant and Peter Andrews, starting in the 1970s.

What originally drew you towards human evolution studies?

My interest in human evolution started at primary school - I was fascinated by fossils, and at the age of about 9 I did a school project on Neanderthals, having heard a BBC radio programme for schools. I wish I still had that project! My interest grew through my school years, but I had no idea that I could actually study in this area (I was from a working-class background and only looking at the career choices offered by teachers and the school library). So, I planned to do medicine, with a place at medical school lined up. Then by chance I was given University College London's prospectus - it was arranged alphabetically, and Anthropology was at the beginning. The course offered archaeology, human evolution, genetics and social anthropology. Suddenly medicine seemed less appealing. So I phoned UCL (this was long before the internet!), was invited for an interview, and they offered me a place. Much to the amazement of my teachers and parents, I dropped medicine at the last minute and took up this study subject, which I had only just learnt existed.

[14] Natural History Museum, London, U.K.; c.stringer@nhm.ac.uk

Where did you study for your PhD, what was your topic and who was your supervisor? How did you choose these things?

1969 was a bad year to start post-grad studies following the student riots of 1968, and I was lucky to find a temporary job at the Natural History Museum while 3 mentors tried to find me PhD funding – Don Brothwell at the Natural History Museum, Michael Day at Middlesex Hospital Medical School, and Bob Martin at UCL. In the end my PhD chose me in 1970 when Jonathan Musgrave, newly arrived in Anatomy at Bristol Medical School, was offered spare funding for a PhD student by his Head of Department, and asked around for likely candidates to study something on Neanderthals (he had studied their hand bones). I opted for the project Don and I had put together - 'A Multivariate Study of Cranial Variation in Middle and Upper Pleistocene Human Populations'.

Chris on his PhD trip around Europe (1971).

What were the findings from your PhD?

Testing the (then) mainstream view that Neanderthals were likely ancestors for Upper Palaeolithic humans, based on comparisons of skull shape, was an important part of my PhD. I concluded that they were not and noted that African fossils like Omo 1 (from Ethiopia) looked a better candidate for that ancestry. But the evidence was too thin at that time to build a convincing alternative scenario of where modern humans had evolved.

What projects are you currently working on at the Natural History Museum? Have you got any exciting results from these so far?

I'm working on a number of different projects involving fossils from Europe, Africa, the Levant, China and Indonesia. Comparing the fragmentary fossil evidence from Boxgrove with the larger samples from the Sima de los Huesos at Atapuerca is one of them. And I was really pleased to see the Broken Hill dating project finally completed and published after more than 20 years (Grün *et al*., 2020).

Chris studying the Dar es-Soltan skull in Rabat (2004).

Are you currently working on any upcoming exhibitions at the Natural History Museum?

We've just added the reconstructed head of 'Cheddar Man' to our Human Evolution exhibition. But our current exhibition is already 5 years old, and it would be great to see an even more ambitious presentation of the evidence, with fuller treatment of the early African story and the contributions of palaeogenetics.

What has been the highlight of your career so far?

Well, the 1988 *Science* paper with Peter Andrews is probably the one I'm most proud of (Stringer and Andrews, 1988), and it came at a crucial time in the debate about our African origins. But the 2005 and 2010 AHOB (Ancient Human Occupation of Britain) papers on Pakefield and Happisburgh 3 that pushed back the earliest-known occupations in Britain were great team achievements (Ashton *et al*., 2010).

What do you think has been the most revolutionary discovery in your field over the last 5 years?

There have been so many, particularly on the ancient DNA side, but I'll go for *Homo naledi*. It came from an area and time period where many of us assumed we knew at least roughly what was happening, and it reminded us that we really didn't. That something so strange and relatively late in time could be found in a supposedly well-explored cave system near Johannesburg shows that our picture of human evolution is still so incomplete, with no doubt many more surprises to come, and not just from Africa.

What would you be if you were not an anthropologist?

Well, if I hadn't switched to Anthropology, I might well have been a doctor called out of retirement to help fight Coronavirus now! And I was lined up to train as a Biology teacher if my PhD place hadn't come through in 1970. On an alternative path, I'd have loved to be an Astrobiologist

References:

Ashton, N. M., Lewis, S. and Stringer, C. (2010). *The Ancient Human Occupation of Britain.* Volume 14. Elsevier Science. ISBN: 0444535985.

Grün, R., Pike, A., McDermott, F., Eggins, S., Mortimer, G., Aubert, M., Kinsley, L., Joannes-Boyau, R., Rumsey, M., Denys, C., Brink, J., Clark, T. and Stringer, C. (2020). Dating the skull from Broken Hill, Zambia, and its position in human evolution. *Nature,* 580, pp. 372–375. DOI: 10.1038/s41586-020-2165-4.

Humphrey, L. and Stringer, C. (2018). *Our Human Story.* London Natural History Museum. ISBN: 97805650939.

Stringer, C. (2011). *The Origin of Our Species*. Penguin Books. ISBN: 0141037202.

Stringer, C. and Andrews, P. (1988). Genetic and fossil evidence for the origin of modern humans. *Science,* 239(4845), pp. 263–1268. DOI: 10.1126/science.3125610.

Professor Katerina Harvati[15]

Katerina Harvati is a palaeoanthropologist at the Eberhard Karls University of Tübingen. She heads the Palaeoanthropology group at the Senckenberg Centre for Human Evolution and Palaoenvrionment (SCHEP). Her team's research focuses on Neanderthal paleobiology and modern human origins; functional anatomy, adaptation and relationship of skeletal morphology to genetics and environment in primates and humans; growth and development in human and non-human primates; and human skeletal analysis. Katerina's research has contributed hugely to the understanding of how morphological variability relates to population history and the environment, and her recent work on the fossil human remains from Apidima Cave, Southern Greece, may have pushed back the arrival of *Homo sapiens* in Europe by more than 150 thousand years (Harvati *et al*., 2019).

What are your research interests and your particular area of expertise?

In general, I am interested in Pleistocene humans. I work mainly on Neanderthal evolution and paleobiology, as well as on modern human origins and the interactions between skeletal phenotype, population history and environment. But I find many topics fascinating, including primate evolution, life history, evolution of the brain and cognition, and more...

What originally drew you towards human evolution studies?

I was always fascinated by the past. I always liked to imagine what it would have been like to live in another era and what the lives of past people would have been like. Growing up in Greece, I was of course surrounded by remnants of the past so this was something that was very natural for me. However I did not discover anthropology until University, and it became clear that this would be my major. I was hooked for good after my first experience in the field – at the Koobi Fora fieldschool back in 1993.

What was your PhD topic? Where did you complete your PhD and who was your supervisor?

I did my PhD at the City University of New York and New York Consortium in Evolutionary Primatology (NYCEP). As part of NYCEP I worked mainly at the American Museum of Natural History, where I also held a PhD fellowship in Anthropology/Paleontology. I defended in 2001, and my topic was on the taxonomic position of Neanderthals using reference models (Harvati *et al*., 2004) and 3D geometric morphometrics approaches (Harvati, 2003). My supervisor was Eric Delson.

[15] Senckenberg Centre for Human Evolution and Palaoenvrionment, University of Tubingen, Germany; katerina.harvati@ifu.uni-tuebingen.de

Katerina in the field at the Marathousa-1, a Lower Paleolithic elephant butchering site in Megalopolis, Greece. Marathousa-1, currently the oldest archaeological site known from Greece at ca. 450 ka, was discovered by a joint team from the Ephorate of Paleoanthropology and Speleology (Greek Ministry of Culture) and the Tübingen Paleoanthropology group in 2013, as part of the research conducted in the frame of Katerina's ERC Starting Grant 'Paleoanthropology at the Gates of Europe' (see Panagopoulou et al., 2018).

After your PhD, what positions have you held and where?

I was very fortunate to secure a tenure track position at New York University. I was there from 2001 to 2004, when I was recruited to join the newly formed Department of Human Evolution at the Max Planck Institute for Evolutionary Anthropology in Leipzig as senior researcher. I stayed at the MPI until 2009, when I moved to the University of Tübingen as Full Professor, and I have been here ever since!

What current projects are you working on? Where do you hope these go in the future?

Well, there are quite a few! From trauma and stress patterns in the Paleolithic, to evolution of tool making behavior, to hybridization in the fossil record, to the paleoanthropology of Greece....and others. I think there are so many interesting questions to be asked, especially in this exciting time of discovery in paleoanthropology, and I am delighted that my team and I are lucky enough to work on many different fascinating topics.

In the field at Tsiotra Vrissi, an Early Pleistocene paleontological site in Northern Greece. The site was discovered by a joint team from the Aristotle University of Thessaloniki and the Tübingen Paleoanthropology group in 2014, as part of the research conducted in the frame of Katerina's ERC Starting Grant 'Paleoanthropology at the Gates of Europe' (see Konidaris et al., 2015).

What project or publication are you most proud of?

My first paper will always have a very special place in my heart, even though it was on a topic that I no longer work on, primate life history (Harvati, 2000). This article was based on my Master's thesis, and it was my first real research project, on colobine monkey dental eruption patterns. I submitted it in the late 1990s, and this was before submissions became electronic, so everything was sent in by post in hard copy, and the waiting times were very long. It was also before digital images, so I developed all the photographs myself from film at the American Museum of Natural History dark room, and had to do it over again a few times to get it just right! It was a labor of love and I was (and still am) very proud of it.

Beyond that, I am also very happy and proud to have had the opportunity over the last two years to work, together with my team and my colleagues at the University of Athens, on the human fossils from Apidima, Southern Greece. These fossils are among the most important ever found in Greece, and it was a real pleasure and honour to be able to work on them and to produce our paper in Nature last year (Harvati *et al*., 2019).

What do you think has been the most revolutionary discovery in your field over the last 5 years?

There have been so many new discoveries in recent years in paleoanthropology, including fantastic new fossils like *Homo naledi* or *Homo luzonensis*, or our own Apidima 1 early *Homo sapiens* specimen; as well as fascinating advances from paleogenomics and paleoproteomics that have been able to add such a great level of detail to our understanding of evolutionary processes in human evolution.

What advice would you give to a student interested in pursuing a career in your field?

I think that, given the scarcity of jobs in academia in general, and particularly in paleoanthropology, students really need to evaluate their priorities in life, especially if they are considering a serious and difficult commitment, such as a PhD. Students should be aware of the possibilities for funding and what the requirements for that would be. They should also research their prospective institution and supervisor: email this person and find out about their work and possibilities to work with them before making a decision. Talk to current students. Last but not least, say yes to opportunities that present themselves, and hunt every opportunity down: you never know the positive developments that they can lead to - this has been my experience!

Katerina in her office in Tubingen.

How has academia changed since you did your PhD?

As I mentioned above, there have been tremendous changes in technology and the way we go about our everyday work, including the rise of the laptop computer, digital images and electronic articles and journals, and, more recently, open access publishing and digital data platforms, to mention a few big ones. There have been equally amazing advances in the scientific approaches and analyses that are now possible, from ancient DNA from fossil humans (considered impossible when I started my PhD in 1994) to microCT and surface scanning and 3d virtual anthropology. These are all amazing advances that have made it possible for our field to move forward by leaps and bounds. A downside of that is the increasingly rapid pace of scientific work, which reduces the time one can invest in digesting each announcement before the next one is made.

There have been fewer changes in other aspects of academia: for example, although there are now more senior women than ever before in bioanthropology, paleoanthropology and human evolution remain male-dominated, and our field in general lacks in diversity. Nevertheless, I think some important steps have been taken towards addressing thorny issues in our discipline, such as sexual harassment or colonialist attitudes in research, for example. Twenty years ago even to talk about these issues would be nearly unthinkable.

References:

Harvati, K. (2000). Dental eruption sequence among colobine primates. *American Journal of Physical Anthropology*, 112, pp 69–85. DOI: 10.1002/(SICI)1096-8644(200005)112:1%3C69::AID-AJPA8%3E3.0.CO;2-I

Harvati, K. (2003). The Neanderthal taxonomic position: models of intra-and inter-specific craniofacial variation. *Journal of Human Evolution,* 44(1), pp. 107-132. DOI: 10.1016/S0047-2484(02)00208-7.

Harvati, K., Frost, S. R. and McNulty, K. P. (2004). Neanderthal taxonomy reconsidered: implications of 3D primate models of intra-and interspecific differences. *Proceedings of the National Academy of Sciences,* 101(5), pp. 1147=1152. DOI: 10.1073/pnas.0308085100.

Harvati, K., Röding, C., Bosman, A. M., Karakostis, F. A., Grün, R., Stringer, C., Karkanas, P., Thompson, N. C., Koutoulidis, V., Moulopoulos, L. A., Gorgoulis, V. G., and Kouloukoussa, M. (2019). Apidima Cave fossils provide earliest evidence of Homo sapiens in Eurasia. *Nature,* 571(7766), pp. 500-504. DOI: 10.1038/s41586-019-1376-z.

Konidaris, G., Tourloukis, V., Kostopoulos, D.S., Thompson, N., Giusti, D., Mihailidis, D., Koufos, G.D. and Harvati, K. (2015). New vertebrate localities from the Early Pleistocene of Mygdonia Basin (Macedonia, Greece): Preliminary results. *Comptes Rendus Palevol,* 14, pp. 353-362. DOI: 10.1016/j.crpv.2015.05.004.

Panagopoulou, E., Tourloukis, V., Thompson, N., Konidaris, G., Athanassiou, A., Giusti, D., Tsartsidou, G., Karkanas, P. and Harvati, K. (2018). The Lower Palaeolithic site of Marathousa 1, Megalopolis, Greece: overview of the evidence. *Quaternary International, SI Human Evolution at the Gates of Europe.* 497, pp. 33-46. DOI: 10.1016/j.quaint.2018.06.031.

Professor Bernard Wood[16]

Photo by George Washington University.

Bernard Wood is a comparative anatomist and palaeoanthropologist at George Washington University (GWU). Bernard originally trained in medicine at the University of London before moving into full time research and teaching. He also previously worked at the University of Liverpool and was appointed Dean of the Medical School before moving to the USA in 1997. As well as holding the position of Professor of Human Origins at GWU, he is an Adjunct Senior Scientist at the National Museum of Natural History of the Smithsonian Institution. His research focuses on hominin systematics, and in particular on ways to improve the reliability of hypotheses about the relationships among fossil hominins. He is also interested in improving the accessibility of information about the hominin fossil record.

What are your research interests and your particular area of expertise within anthropology?

I am a biological anthropologist who is interested in the earlier stages of human evolutionary history -- once fossils look at all like modern humans, I lose interest. I use my training and expertise in primate and human anatomy to interpret the human fossil record. My main questions are how many taxa are represented, and how are those taxa related (Wood *et al*., 2020). I would dearly like to know how you can reliably tell the ancestors of modern humans from their non-ancestral close relatives. The early hominin taxon that intrigues me is *Paranthropus boisei* (Wood and Constantino, 2007). They are especially weird creatures that lived at the same time as early *Homo*. Most researchers steer clear of them because they are almost certainly *not* the ancestors of modern humans, but that is precisely what makes them appealing to me (Wood and Patterson, 2020). What were they doing so successfully for a million years, or so?

You have pursued a dual career in Human Anatomy and Palaeoanthropology. How did you become interested in evolutionary questions?

That interest began when I was taking classes for an undergraduate degree in Anatomy when I was a medical student. I enjoyed, and was good at, anatomy, so I figured I should do something I was likely to be successful at. I had studied evolution in A-level biology at school, but I had no special interest in natural history, nor was I one of those children who was fascinated by natural history museums. But I enjoyed learning about living and fossil primates in a class taught by John Napier. Michael Day taught a separate course about human evolution, and I was intrigued by the idea that fossil evidence might help us understand how we, modern humans, came to be such an *odd* ape. Michael Day gave me a foot bone from Olduvai to analyze for my project, and it resulted in a paper -- not a very good one -- that launched my career as a palaeoanthropologist. I was still planning to be a surgeon, but for a whole bunch of reasons palaeoanthropology won out.

[16] Department of Anthropology, George Washington University, USA; bernardawood@gmail.com

What was your PhD experience like?

I realized that if I wanted to be an academic I needed to have a PhD, but I was already working as a Junior Lecturer teaching anatomy to medical students, as preparation for taking the first part of the FRCS exams. I lectured five or six times a week in the morning, and we spent every afternoon, except Wednesdays, teaching in the dissecting room, so I could only collect the data for my PhD during the student holidays. I had been assigned the task of making sense of the cranial remains from East Turkana, so decided to try to understand as much as I could about intraspecific variation, and in particular sexual dimorphism. The conventional wisdom was that most of the differences within species were size differences, whereas among species the differences were a mixture of size and shape. It turns out that shape differed within as well as among species, but the shape differences within species were mostly predictable, because they were due to allometry acting on size differences. I am not a naturally quantitative person, so I was especially grateful to a colleague, Michael Clarke, who became a close friend, for helping me understand multivariate analysis, which in the early 1970s was still in its infancy.

Looking at newly-recovered hominin fossils, brought down to Nairobi by Don Johanson from Hadar in 1973, at the old Center for Prehistory and Palaeontology at the National Museums of Kenya. From left to right, Tim White, Richard Leakey, Bernard Wood and Don Johanson. Photo by Bob Campbell.

At the University of Liverpool, you developed a hominid palaeontology group over several years. What were the interests of this group?

It was part of generally ramping up research in what was mainly a teaching-oriented department. I tried to recruit people for the Hominid Palaeontology Research Group with interests that complemented mine. Robin Crompton was interested in functional morphology, and Gabriele Macho in life history. We also had post-docs -- for example Fred Spoor and Alan Turner -- and graduate students who also

broadened the HPRG's research interests. Joan Taylor in Archaeology and the folks in Earth Sciences added to the breadth of research interests relevant to human evolution at Liverpool, and Joan helped recruit John Gowlett.

At East Turkana you worked alongside other well-known scientists, especially Richard Leakey and Glynn Isaac. Do you look on that as a 'golden era' of exploring for early hominins?

I am more interested in the analysis of fossil evidence, than in its discovery and recovery, but the opportunity to spend time at East Turkana gave me an invaluable perspective on the strengths and weaknesses of the fossil, archeological and contextual evidence for human evolution. First Richard, and then Glynn and Richard, assembled an impressive group of mainly young researchers to help collect and interpret the evidence. Apart from my role in interpreting the fossil hominins, I was mainly an onlooker with respect to the fieldwork. But, the chance to be out in the field with Kay Behrensmeyer surveying the locations where hominins had been found, and working on the team with Glynn on his 'Scatter between the patches' project, provided me with crash courses on stratigraphy and archeology. More than that, discussions in the field, and over the dinner table, with these and other fine scientists, provided me with a valuable scientific education. Richard Leakey's generosity enabled my career; Glynn Isaac was a major influence on the way I approach my research.

Consultations in the field during the Earliest Man and Environments in the lake Rudolf Basin conference in 1973. From left to right, John Harris, Richard Leakey, Meave Leakey, Glynn Isaac, Ian Findlater and Jack Harris. Photo by Bernard Wood.

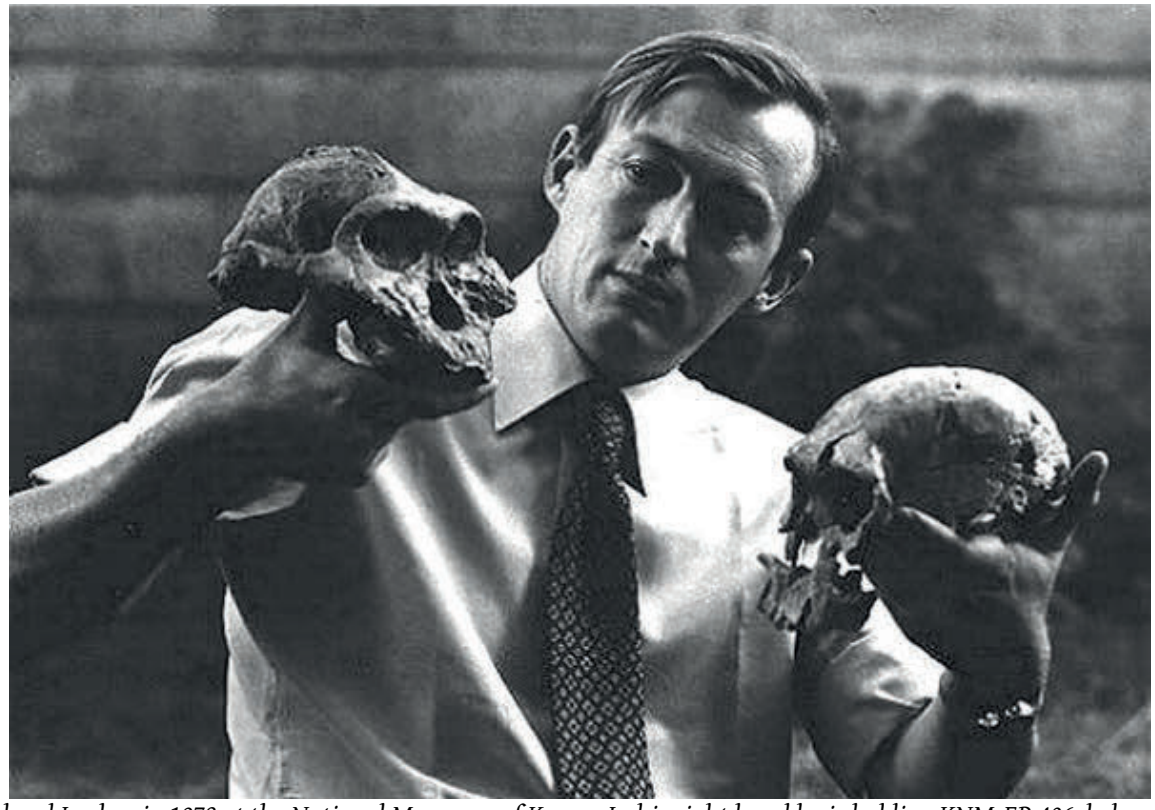
What projects are you currently involved with? Where do you hope these go in the future?

I enjoy sifting through fossil evidence, and then identifying tractable research questions. I come up with many more questions than I have the talent or time to pursue, so my strategy has been to try and interest students and post-docs to do the real work. My current research interests are the ones I listed

in response at the beginning. How can we squeeze more information out of the fossil record to help us be less ignorant about human evolution? With respect to phylogeny reconstruction, I would dearly like to know what aspects of hard-tissue morphology are 'signal' and what are 'noise'? If I had my time again, I think I would have paid more attention to 'evo-devo' questions. For example, how is development modified in *P. boisei* to make its dental enamel so thick, and it's premolars into molars?

What do you enjoy the most about being a paleoanthropologist?

Although I ended up taking mostly science classes at school, my real interest was history. I liked reading about, and trying to understand, what happened in the past, but most of all, what was it like in the past. Being a paleoanthropologist is like being a historian. You are trying to reconstruct evolutionary history from scraps of evidence (Wood, 2019). You need to understand the limitations of that evidence, as well as the opportunities it provides. You also need to be aware of the different scales involved. How can you responsibly extrapolate from an individual, or even a few individuals, to a species, or from evidence from one lake basin to a continent? The other enjoyable aspect of being a paleoanthropologist is working with other paleoanthropologists, who, with a few exceptions, are smart and generous people.

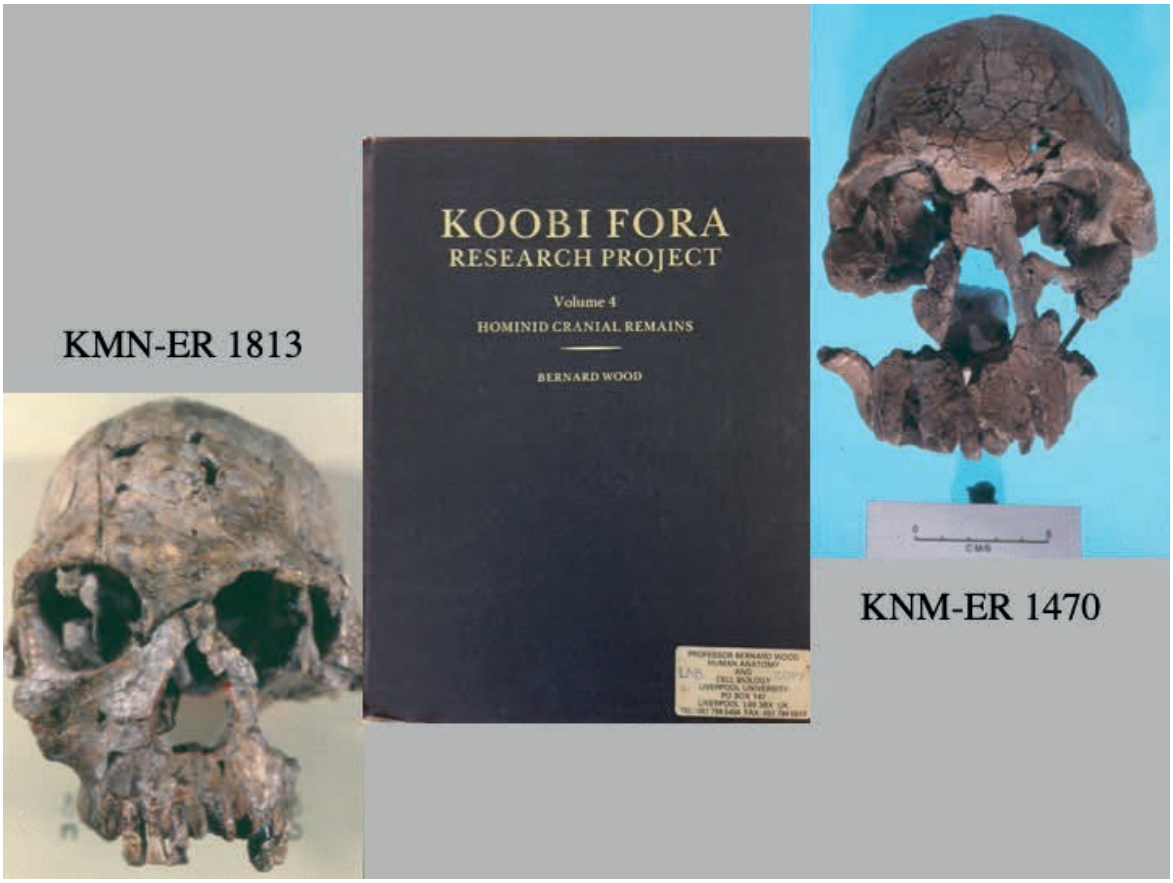


Richard Leakey in 1972 at the National Museums of Kenya. In his right hand he is holding KNM-ER 406, belonging to Paranthropus boisei, and in his left KNM-ER 1470, belonging to Homo rudolfensis. Photo by Bob Campbell.

Which of your several major monographs, and an encyclopaedia, do you regard as your most worthwhile accomplishment?

That's a tough one. I worked on the research that was summarized in the monograph about the cranial remains from East Turkana (aka Koobi Fora) for about 15 years (Wood, 1991). My interpretations of the evidence were not necessarily the same as Richard Leakey's, so it was a lonely, and at times a stressful, task. But I saw it through to its conclusion, and that pleased me then, and it still pleases me now. I get

satisfaction from taking a complex problem, and reducing it to a relatively simple question, so my publications that do that are the ones I take most pride in. The encyclopaedia of human evolution was borne out of my frustration that there was no human evolution equivalent of a medical dictionary (Wood, 2011). Like most of my publications, it was written for me. I write papers about topics I don't understand. Why would I bother to write about something I *think* I understand?



In his 1991 monograph on the cranial remains from East Turkana, Bernard argued that KNM-ER 1470, on the right, and KNM-ER 1813, on the left, were unlikely to belong to the same species.

Do you have any advice for current PhD students?

Work out what you are good at. Pick a topic that plays to your strengths, not your weaknesses. Conventional wisdom is fertile ground for PhD topics. Once something is conventional wisdom, people stop thinking critically about it. You can look at it afresh. My only important advice is to find an advisor you respect and admire, and who you think you can get on with. They will be your colleague for life, so choose wisely.

References:

Wood, B. (1991). *Koobi Fora Research Project: Hominin Cranial Remains*. Volume 1. Oxford University Press, USA.

Wood, B. (2011). *Wiley-Blackwell Encyclopaedia of Human Evolution*. Blackwell Publishing Ltd. DOI: 10.1002/9781444342499.

Wood, B. (2019). *Human Evolution: A Very Short Introduction*. Second Edition. Oxford University Press, New York, pp. 1-40. ISBN: 978-0-19-883174-7.

Wood, B. and Constantino, P. (2007). *Paranthropus boisei*: Fifty years of evidence and analysis. *American Journal of Physical Anthropology,* 134(S45), pp. 106-132.

Wood, B., Doherty, D. and Boyd, E. (2020). Hominin taxic diversity. *Oxford Research Encyclopedia of Anthropology.*

Part 4: Primatology and Evolutionary Anthropology

Professor Susana Carvalho[17]

Professor Susana Carvalho is a primatologist and palaeoanthropologist at the University of Oxford. She is the head of Primate Models for Behavioural Evolution Lab and has directed the Paleo-Primate Project Gorongosa in Mozambique since 2015, leading an interdisciplinary team to carry out an unprecedented approach to understanding human origins and adaptations. She was also one of the main founders of the field of primate archaeology, studying the stone-tool use of non-human primates to understand the origins of cultural behaviour.

Susana in Gorongosa National Park, 2017. Photo by Luke Stalley.

What are your research interests and your particular area of expertise?

I am very interested in early human evolution and fascinated by extant non-human primates. So far, I have focused my career studying the origins and evolution of technology, of bipedalism and currently I am interested in using extant primates to understand more about the evolution of predatory behaviours in hominins.

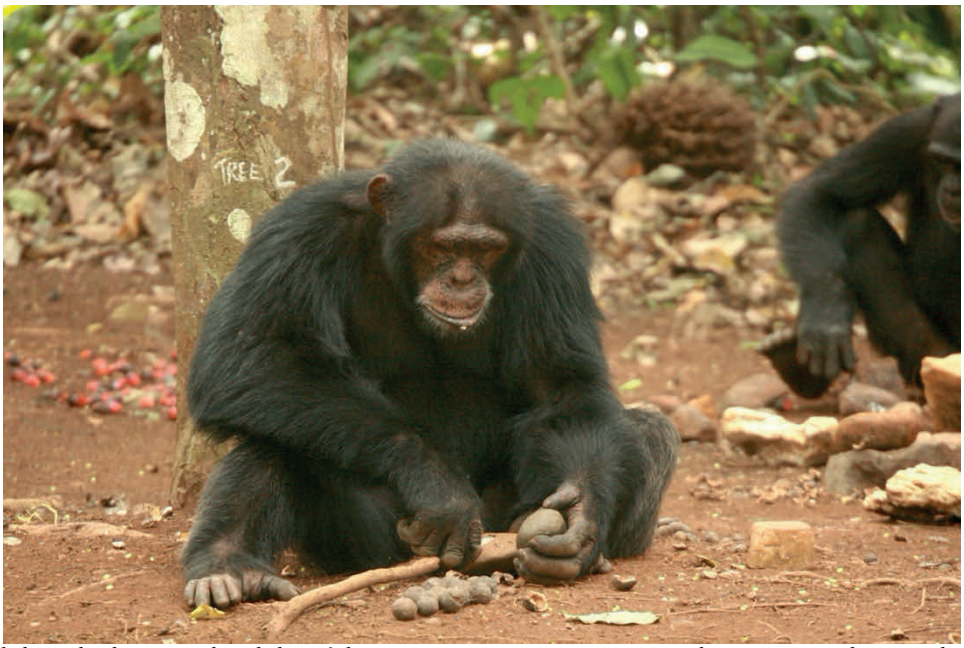
What originally drew you towards human evolution studies?

My first degree was in archaeology and I worked for 7 years as an archaeologist before deciding to pursue an MSc in Human Evolution. I was always fascinated with exploration and discoveries. I dreamed of exploring inaccessible places, and truly loved history, how powerful and ground-breaking was the knowledge of our ancestors. I still think that is the case! I think I could have pursued multiple paths, as long as it would include some quest to explore something difficult and new. I grew up in Portugal, just after the dictatorship ended, during a time when David Attenborough documentaries started to expand our horizons about the natural world, and when Indiana Jones stirred an entire generation (it is true, no matter how shallow that idea now sounds!). I was also an avid reader, and loved travel stories, early explorers' diaries, books on the pre-classics and classic societies, and basically any mysterious account of a faraway place. But, archaeology *per se* became, to some extent, a disillusionment. I realised I was much more interested in the lives of the humans behind the objects that we were digging. The first degree in Human Evolution in Portugal had recently opened in Coimbra and I decided to take my chances and apply. Somehow, I convinced Prof. Eugenia Cunha that I could do the degree despite my background in Humanities.

[17] Institute of Cognitive and Evolutionary Anthropology, University of Oxford, UK; susana.carvalho@anthro.ox.ac.uk

Why did you decide to do a PhD? Was your PhD experience what you had expected?

I did not decide to do a PhD and I had little intention of pursuing a career in academia! For my Masters, I ended up spending 6 months in Guinea Conakry to do my dissertation on the *chaine operatoire* of wild chimpanzee nut-cracking (Carvalho *et al.*, 2008). I presented the results at a conference in Lisbon. I got an email from Bill McGrew a few days later asking me if I had considered doing a PhD in Cambridge...it is a long story, but I left my permanent job and my house and went to Cambridge to start my PhD in 2007. My experience was way beyond anything I could have imagined, even in my wildest dreams! I spent about 2 years in Guinea with the chimpanzees, punctuated by summers at the Koobi Fora Field School in Kenya, a 3-month fellowship in Japan, and so much more. It was a full immersion in everything I love to do, studying wild primates and exploring paleoanthropological sites, surrounded by an excellent group of colleagues and mentors, with the feeling that I was truly pushing the boundaries of something. Of course, retrospectively this all sounds great, but field work time was really hard and challenging, and personal life changed substantially during this period, so there were many adjustments and balls to keep in the air! I did feel that starting my PhD at an older age and my previous working experience may have buffered me against some of the stresses of multi-tasking and gave me a different perspective on the 'relative' importance of doing a PhD.



Yolo - the adult male that was the alpha of the Bossou group, in Guinea Conakry - nut-cracking at the outdoor lab in the forest.

What were the findings from your PhD?

Overall, my discovery that the nut-cracking sites of chimpanzees matched, to a great extent, the strategies of use and exploitation of resources that had been described for early hominin sites. I reported for the first time the variation of tool types depending on the nut species targeted, the chimpanzee preference for reusing composite-tools, and the distribution and density of tools at chimpanzee nut-cracking sites (Carvalho *et al.*, 2009). Of relevance were also the new chimpanzee nut-cracking sites I found in a very unexplored forest of Guinea (Diecké) (Carvalho *et al.*, 2007). In terms of technological-related behaviours, I found that chimpanzees increase their bipedal locomotion when transporting foods (nuts/papayas) that are valuable and unpredictable – that was a nice test of the carrying hypothesis done in the wild (Carvalho *et al.*, 2012).

Susana measuring chimpanzee tools with her colleague, Boniface Zogbila. Photo by Jules Dore.

After your PhD, what positions have you held and where?

I was a Junior Research Fellowship (JRF) at Clare Hall College, when I was still a PhD student at Cambridge, then briefly moved to a Post-doctoral position at Oxford on an ERC project named "Primate Archaeology", and from there I moved to the USA where I was a post-doc at George Washington University, with Bernard Wood. This corresponds to a short period of less than 3 years, and the projects were all expansions of my Primate Archaeology original work, now thinking of applying the methods and principles to perishable tools, comparing sites, and taking the search for the 'Older than the Oldowan' seriously in eastern Africa (Carvalho and McGrew, 2012).

You are one of the main founders of the field of primate archaeology: what exactly is primate archaeology? Why is it important for understanding human evolution?

Primate archaeology - unlike the archaeology of primates (Haslam *et al*., 2009) - requires scientists trained in both fields. It aims to model the evolution of technological behaviour in the primate 0rder through a combination of methods to record behaviours and tools while they are being used and after use. It also addresses processes of site formation *in vivo* and focuses on strategies of exploitation of resources in the tool using areas. Technological evolution has been intrinsically linked to hominin evolution, but we have written our archaeology books without considering our primate living relatives, who can be excellent tool users and are leaving behind important archaeological sites. I can just name a few 'micro-revolutions' that have happened since 2007, directly related with the research developed by Primate Archaeologists: systematic surveys to find archaeological sites older than 2.6 Ma -- and the acceptance that technology is not an exclusive of our genus; excavations of non-human primate sites that date back thousands of years; the discovery that monkeys unintentionally flake tools leaving those 'archaeological' signatures behind and, more recently, the discovery that perishable tools may be detected in the archaeological records via durable scarifications left in the raw material sourced – this will open an entire new branch within Primate Archaeology. I think the best and more impactful is still to come, as we start to accept that not all archaeological sites have to be human, and we do not have to continue restricted to behaviours encased in stone tools. I like to think we are picking up on an interdisciplinary spirit started by Louis Leakey. He was at the forefront of the first primatological field studies with great apes, while working in the East African Rift System (EARS) and focusing on studying past evidence of human evolution.

Susana with Rene Bobe and Zeray Alemseged at Gorongosa (2017). Photo by Luke Stalley.

What current research projects are you working on? Where do you hope these will go in the future?

My main project now is the Paleo-Primate Project Gorongosa (PPPG). I like to think this is a truly interdisciplinary project in the EARS where researchers working with present and past data are collecting very different sets of information that will contribute to answer common questions about our origins. To do this you need a "Gorongosa": a place with a modern mosaic of habitats and exceptional biodiversity, but also with fossil sites and with a diversity of contexts, including open air sites and caves. Gorongosa has it all and is located in a geographic zone that is critical to understand our biogeography (Habermann *et al.*, 2019). Within the PPPG, I co-direct excavations at our Miocene fossil sites, and I also conduct primatological research (with baboons), focusing on bipedalism and predatory behaviour. I continue to work in a series of projects within the Primate Archaeology framework, with ongoing collaborations in Guinea, Kenya, South Africa and Germany. I like to focus on the present, but I hope the Paleo-Primate Project will open novel ways of working and, most importantly, that I may see my Mozambican students leading our research and bringing prosperity to the region linked to the many discoveries we are making!

Following baboons at Gorongosa (2016).

What is the Oxford-Gorongosa Paleo-Primate Field School? What have been your favourite memories from this project?

Our field school started in 2018 and is a collaboration between the University of Oxford and Gorongosa National Park. We provide training in primatology, paleoanthropology, archaeology, geology, speleology and ecology – and I think we may be the only field school covering all these disciplines. The field school is well integrated with the PPPG and students are able to develop their own UG or PG

projects in connection to the project and mentored by a senior expert in one of the disciplines. I wanted this to be as inclusive as we can: we don't charge tuition fees, and we help students applying to small grants to cover the expenses. 50% or more of the students are from Mozambique. I have too many wonderful memories, the day when we found our first fossil site, the day we found our first primate fossil, the first time we were able to follow baboons and actually see what they do, the nights around the campfire, that day when I found a lion on foot about 20 m from me...all the wonderful people that I have been able to meet and work with in Gorongosa – I have the best time there working with the best people.

Fieldwork at Gorongosa (2018).

What other projects are being conducted in the Primate Models for Behavioural Evolution Lab at the University of Oxford?

The lab has grown so much since 2016. We have almost 20 researchers at present. What is common to all is a shared interest in primates, the evolution of behaviour and human evolution. There are so many exciting projects, just to name a few: the archaeology of the perishable (Alejandra Pascual-Garrido), the ecology of stone tool use (Katarina Almeida-Warren), chimpanzee technological efficiency (Sophie Berdugo), behavioural responses to predation pressure (Philippa Hammond), cognition and culture in primate play (Alex Mielke), computer vision and machine learning approaches to finding fossil sites (João Coelho), our ancestors climate as a predictor of habitat change (Thomas Püschel). I recommend visiting our website and exploring all the ongoing research!

If you weren't a primatologist/paleoanthropologist, what career would you choose?

A naturalist – it is sadly going extinct due to the pressures of this crazy world that does not allow scientists to take time to study their subjects in much depth. But I used to be a DJ in my free time (!) and I would have been happy working in the music world or cooking (Portuguese food!).

References:

Carvalho, S., Sousa, C. and Matsuzawa, T. (2007). New Nut-Cracking Sites in Diecké Forest, Guinea: An Overview of the Surveys. *Pan Africa News,* 14(1), pp. 11-13.

Carvalho, S., Cunha, E., Sousa, C. and Matsuzawa, T. (2008). Chaînes opératoires and resource-exploitation strategies in chimpanzee (*Pan troglodytes*) nut cracking. *Journal of Human Evolution,* 55(1), pp. 148-163. DOI: 10.1016/j.jhevol.2008.02.005.

Carvalho, S., Biro, D., McGrew, W. C. and Matsuzawa, T. (2009). Tool-composite reuse in wild chimpanzees (*Pan troglodytes*): archaeologically invisible steps in the technological evolution of early hominins?. *Animal Cognition,* 12, pp. 103–114. DOI: 10.1007/s10071-009-0271-7.

Carvalho, S. and McGrew, W. (2012). The origins of the Oldowan: why chimpanzees (*Pan troglodytes*) still are good models for technological evolution in Africa. In M. Dominguez-Rodrigo (Ed.), *Stone tools and Fossil Bones: Debates in the Archaeology of Human Origins.* Cambridge University Press. DOI: 10.1017/CBO9781139149327.010.

Carvalho, S., Biro, D., Cunha, E., Hockings, K., McGrew, W. C., Richmond, B. G. and Matsuzawa, T. (2012). Chimpanzee carrying behaviour and the origins of human bipedality. *Current Biology* 22(6), pp. R180-181. DOI: 10.1016/j.cub.2012.01.052.

Habermann, J. M., Alberti, M., Aldeias, A., Alemseged, Z., Archer, W., Bamford, M., Biro, D., Braun, D. R., Capelli, C., Cunha, E., Ferreira Da Silva, M., Ludecke, T., Madiquida, H., Martinez, F. L., Mathe, J., Negash, N., Paulo, M. L., Pinto, M., Stalmans, M., Tata Regala, F.,Wynn, G. J., Bobe, R. and Carvalho, S. (2019). Gorongosa by the sea: First Miocene fossil sites from the Urema Rift, central Mozambique, and their coastal paleoenvironmental and paleoecological contexts. *Palaeogeography, Palaeoclimatology, Paleoecology,* 514, pp. 723-738. DOI: 10.1016/j.palaeo.2018.09.032.

Haslam, M., Hernandez-Aguilar, A., Ling, V. Carvalho, S., de la Torre, I., DeStefano, A., Du, A., Hardy, B., Harris, J., Marchant, L., Matsuzawa, T., McGrew, W., Mercader, J., Mora, R., Petraglia, M., Roche, H., Visalberghi, E. and Warren, R. (2009). Primate archaeology. *Nature*, 460, pp. 339–344. DOI: 10.1038/nature08188.

Dr Isabelle Winder[18]

Isabelle Winder is an evolutionary anthropologist at Bangor University. Her research covers a wide range of topics, including primatology, comparative anatomy, primate responses to climate change and, of course, human evolution. Isabelle is currently a senior lecturer in Zoology at Bangor University where she teaches a number of specialist modules, including a field course in Uganda. She has also worked at the Palaeo Centre at the University of York and is an Honorary Research Associate in the Department of Musculoskeletal Biology and Institute for Ageing and Chronic Disease at the University of Liverpool.

What are your research interests and your particular area of expertise?

I have quite broad research interests, and usually describe myself as a "question-driven" researcher. By that I suppose I mean I prefer to focus on a question and learn the methods I need to tackle them rather than develop a particular methodological expertise which I could apply systematically to different species or topics. The questions that most interest me have to do with how primates (and within that group, humans) came to be the way they are, and what the implications are for understanding ourselves and our future.

Within that, I have a longstanding interest in how interactions with the environment have shaped primates, including hominins. I use mapping approaches (GIS or geographical information systems) to analyse patterns in the distribution of a primate and explore its ecology and associations with different environments. I also work on anatomy. This started out as an interest in how anatomy is shaped by the environments organisms grow and evolve in. It has since turned into a broader interest in the relative importance of environment and other factors like structural constraint, chance, use and behaviour in shaping body structures. Just recently, I have also expanded my ecological work to look at how primates are responding to anthropogenic habitat change.

Isabelle (left) and colleague Vivien Shaw (right) with their students presenting posters at the Anatomical Society Meeting in 2019.

[18] School of Natural Sciences, Bangor University, UK; i.c.winder@bangor.ac.uk

What originally drew you towards human evolution studies?

I didn't have a direct route into human evolution: my interests always seemed to cross disciplinary boundaries, and I didn't focus on palaeoanthropology at all until my Masters. I think my fascination with evolution and humans' place in the natural world (past and present) was always there. Certainly, I don't remember any particular event which could represent a starting point for it. I ended up studying Geography at University, because it was the subject that seemed most likely to let me study both the natural and human worlds. Then I did a Masters in Palaeoanthropology and a PhD in Archaeology.

I do remember always enjoying museums, including natural history collections and places that focused on people, and was always drawn to non-fiction reading (especially about evolution). I suppose I have been thinking about the big questions I study now for a very long time – it just took me a long time to decide that they would be part of my career.

What was your PhD topic? How did you choose this and who was your supervisor?

My PhD was on the role of landscapes in human evolution, and how the spatial structure of the places our ancestors have potentially shaped our deep history. It was another example of my tendency to pick a question and follow it wherever it happened to go: the chapters were a series of case-studies that each unpicked different aspects of the same problem. For one I mapped extant African environments to see how these were patterned and which underlying processes drove landscape structure at different scales. Later on, I had chapters looking at how smaller scale variation in landscapes shaped the anatomy of humans and non-human primates, and how our habitat preferences had shifted through hominin history. The main argument was that spatially heterogeneous, complex, dynamic landscapes were significant parts of our evolutionary history.

I chose the topic and supervisor together. My supervisor, Prof. Geoff Bailey, had proposed in a paper in 2006 that the fact that many hominin fossils come from the Rift Valley and the Cradle of Humankind was not just an artefact of preservation bias, but a key to understanding our evolution. Tectonic landscapes are spatially heterogeneous and dynamic (fast changing), and their potential role in primate evolutionary history had otherwise not been studied. The paper captured my interest, and Geoff became my supervisor – my work was part of his ERC-funded project DISPERSE (Dynamic landscapes, coastal environments and hominin dispersals).

After your PhD, where have you worked and on what projects?

I did a post-doc at the University of York, also on the DISPERSE project, and then moved to Bangor as a lecturer after that. My postdoctoral project followed up the same theme, but with more emphasis on evolutionary processes (my PhD had looked mostly at patterns). In particular, I worked on evolutionary complexity and got interested in whether human evolution had been neatly tree-shaped or more reticulate – with hybridisation playing a more significant role than we had previously thought. I also looked more closely at primate behaviour and particularly the kinds of choices non-human or human primates make, with an eye to seeing how our ability to choose how we behave might have shaped our evolution.

What current projects are you working on at Bangor University? What results have you got from these projects so far?

One of the main projects I've got on at the moment is looking at non-human primate responses to climate change. This is a new line of research since I arrived at Bangor, and is proving really interesting. The first bit of it was a project one of my 2017-18 Masters students (Sarah Hill) did looking at baboons. She picked baboons partly out of interest, but also because we've all see the news about baboons raiding crops, encroaching on cities and stealing food from tourists – we tend to assume, as scientists and more generally, that they are resilient creatures. They live all over sub-Saharan Africa, and are all IUCN-listed as being animals of "Least Concern" for conservation, with the single exception of the Guinea baboon which is "Near Threatened" but not yet endangered.

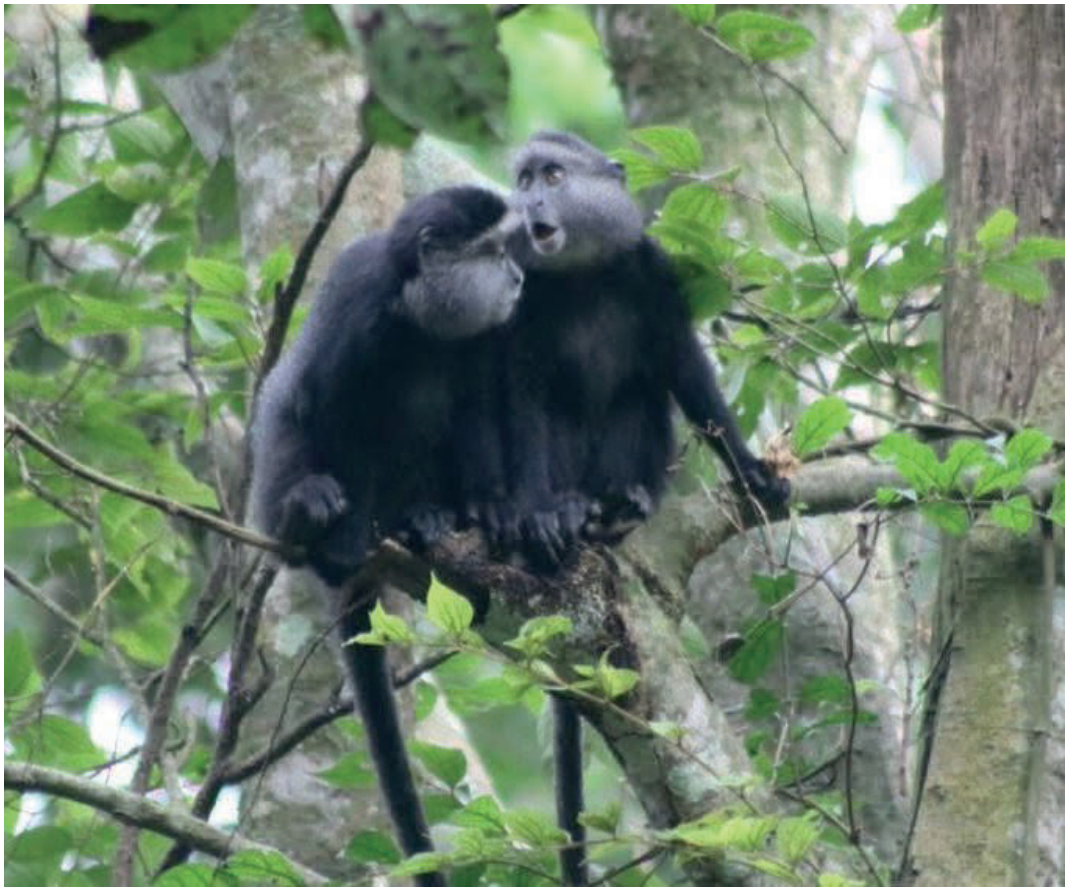
It seemed to us that baboons would be a good test case for modelling future climate change. We assume they're ecologically resilient and flexible, but does that mean they will be all right in the Anthropocene? As it turns out, Sarah found that three of six baboon species were at higher risk than we thought, likely to lose more than a quarter of their suitable habitat by 2070 under most or all of our climate change scenarios. And since we didn't include anything really extreme – all the models were based on models of fairly likely situations with either 2.6 or 6 degrees of warming, not the extreme predictions of 8 degrees – this was obviously concerning.

Since Sarah's work, we have started to look at other taxa too: lorises, gorillas, macaques, south-central American monkeys and more. The results are rarely entirely as we would expect – closely related species won't necessarily respond the same way! Along the way, we are also finding out more about other human impacts, ecological patterns and how communities will change. It's really interesting!

My other big project at the moment is on human evolution more specifically, and follows up the ideas about landscape that I wrote about during my PhD and postdoc. I'm working on synthesising a cluster of ideas about the Extended Synthesis of evolutionary theory, and exploring how these concepts might add to our understanding of our own past. This is still just getting started, but will include some nice bits of modelling that try to expand on simple niche models like the ones we've been building for non-human primates, to try to add more complexity and see how other factors might interact with the ones we already have data on.

Why is your research important for understanding human evolution?

I'd argue that without understanding evolutionary patterns and processes in the non-human primates, we will never be able to understand our own evolutionary history. We think of evolution as being shaped by environments and ecology (including behaviour), but we still have so much to learn about how that works, in specific cases and in general!



Blue Monkeys from Central and East Africa.

What project or publication are you most proud of?

Oh, that's a difficult question! It's usually the most recent one. Overall, I think I'm going to cheat and pick two...

Firstly, I'm very proud of the paper about baboons and climate change (Hill and Winder, 2019). This is the first published bit of that research programme and is based on Sarah's MZool dissertation – which I think is fantastic. It's really unusual to get a paper like that one out of an undergraduate project and I'm an extremely proud supervisor. Plus, I think it has a really important message: apparently resilient, flexible species may be at much higher risk than we thought from anthropogenic impact.

Secondly, the paper I wrote in 2014 about the importance of reticulation in primate evolution (Winder and Winder, 2014) is one I have a real soft spot for. I found doing the research absolutely engrossing, and got to present the ideas at the 2013 Society for the Study of Human Biology symposium and have a great discussion with others there. It was really fun to write, and also (I think) has an interesting message about just how complicated the history of the primates really is.

Does your research have an impact outside of academia?

I suppose that depends what you mean by impact. In terms of practical application, the climate change projects have the most potential. In some of them, we actually suggest places where species will persist and where protected areas might usefully be located, for instance. So far I don't know of specific

instances where these suggestions have been taken up, but it will be interesting to see if we can help more with practical conservation in future.

Otherwise, I think what I aspire to is more about engaging with people outside of academia than necessarily changing what they do. Human evolution is fascinating (OK, I'm biased) and I've always loved the fact that people find it interesting. I enjoy doing things like public lectures, writing for a wider audience and getting outside of the University to talk to people. That's one of my favourite bits of the job, and I like to think it has an impact at least on some of the people I talk to!

What is your favourite and worst thing about academia?

My favourite thing is the fact that no two days are ever the same, and I get to do so many of the things that I enjoy: research, supervision, fieldwork, writing, reading and teaching are all activities I really value and would want to find time for even if I weren't an academic. The fact that I get to have them as my job is just wonderful.

In terms of least favourite things, I think the fact that I know so many brilliant scientists and teachers who are stuck on casual contracts is probably the worst. It seems such a shame that with more students than in any previous generation the sector is increasingly relying on people who are not paid enough to support themselves and have no security. It seems particularly unfair when you remember how much time, energy and money many of those people have already invested in their education.

Isabelle in the field in Kibale National Park, Uganda, with her students. Photo by Alexander Georgiev (@BangorPrimates).

What advice would you give to a student interested in your field of research?

I tried very hard to think of something profound to say here, with limited success. I do think it's important to recognise that the really interesting problems in human evolution are often on the boundaries between disciplines – so having broad interests, and being willing to learn new ways to think and work as you go along, is vital.

It's also important to enjoy what you do. By that I don't really mean enjoying the products (though the elation from a paper finally coming out can be a great short-term motivator). I mean you need to enjoy what you do every day, the process of getting to those results. If you find the work you're doing is consistently boring or frustrating you, you may need to find another method or approach. Avoiding things that make you miserable, at least when that is within your control, is important!

References:

Hill, S. E. and Winder, I. C. (2019). Predicting the impacts of climate change on *Papio* baboon biogeography: Are widespread, generalist primates 'safe'?' *Journal of Biogeography*, 46, pp. 1380– 1405. DOI: 10.1111/jbi.13582.

Winder, I. C. and Winder, N. P. (2014). Reticulate evolution and the human past: an anthropological perspective. *Annals of Human Biology,* 41(4), pp. 300-11. DOI: 10.3109/03014460.2014.922613.

Professor Fiona Jordan[19]

Fiona Jordan is an evolutionary and linguistic anthropologist at the University of Bristol. Her research primarily seeks to understand the evolution of cultural diversity using data, methods and theory from a variety of disciplines, such as biology, psychology, anthropology, and linguistics. She is the leader of the excd (Evolution of Cross-Cultural Diversity) lab, which investigates how the staggering, yet not infinite, variety in human culture has evolved. Prior to her professorship, she has also worked at University College London in the Centre for the Evolution of Cultural Diversity and the Max Planck Institute for Psycholinguists in the Netherlands.

What are your research interests and your particular area of expertise?

Kinship, stories, and plants. Not quite as random as it sounds! My lab's name (Evolution of Cross-Cultural Diversity) tells the overarching interest we have in explaining human cultural variation from different angles and in different domains. And I say "we" because all the research I do is highly collaborative. We're in our last year of a 5-year ERC-funded project 'VariKin', using cultural evolutionary, linguistic, and developmental perspectives to understand kinship system diversity. We've also been wrapping up a project on the cultural transmission of stories in order to investigate what makes a story memorable: the tale, or the teller? In the last few years I've been involved in a number of cross-cultural database initiatives: KinBank for our VariKin project; D-PLACE (the Database of Places, Languages, Cultures & Environments; Kirby *et al*., 2016); CHIELD (Roberts *et al*., 2020); and NumeralBank.

What originally drew you towards human evolution studies?

I was a very 'humanities' student in high school--lots of art history and English and drama--but I had a seventh form biology teacher who did a great job teaching human evolution and introduced me to the notion of anthropology. I did my undergraduate and masters at the University of Auckland in New Zealand, at a time when Anthropology was very 'four-field' and for a while I thought I might be an archaeologist--even took a geology course! But I was also enjoying the psychology in my degree and that was at the time when the 'evolutionary turn' in the social sciences was just starting to take off. So biological anthropology seemed like a brilliant crossroads of all the things I was interested in. So much so that instead of being happy with my BA in Anthropology, I also did a BSc in Biology. Always keen...

What is the Varikin project? Where do you hope this project will go in the future?

The project's full title is "Cultural Evolution of Kinship Diversity: Variation in Language, Cognition and Social Norms Regarding Family." A bit of a mouthful, but the project is a multi-disciplinary attempt to understand why human societies differ in who they class as family. In particular, to understand why across the world we see a variety of ways of categorising kin, and what patterns this variation. For example, in English we have different words for siblings and cousins. But in many languages (Maori from New Zealand is a nice example), speakers use the same words for cousins and siblings. And some

[19] Department of Anthropology and Archaeology, University of Bristol, UK; fiona.jordan@bristol.ac.uk

languages--Hindi, for example-- distinguish types of cousins by the relatives you're related through. But the variety isn't endless. Kinship term patterns have fascinated anthropologists for decades, but cross-cultural studies fell out of favour before we really cracked the puzzles. And now, we have new methods from evolutionary biology, big datasets of natural language use across a range of cultures, and the ability to conduct systematic fieldwork and study how children learn. So we're taking advantage of these new approaches and data to build a global database of kinship terminology patterns, and to use the methods I mentioned to tackle the questions anew.

We've a number of findings in the publication pipeline, but some of our early results showed that shared ancestry (i.e., what language family or group your language is a member of) is a strong predictor of the kinship pattern, and has more of an effect than social norms like marriage or inheritance rules. Anthropologists have argued for one or both of these explanations for many years but our global analysis quantified the trends (Racz *et al.*, 2019). We also tested the claim that the more a word is used, the slower it is to change. This appears to hold for kinship terms--terms for close family members are used more, and they change slowly (actually, super-slowly, compared to other vocabulary. And in work with Datooga children from Tanzania, Alice Mitchell has shown that adults adopt the child's point of view when using kinship terms. Further work comparing across a range of languages has shown this phenomena (e.g. "Where's Granny's bowl?") to be consistent, so it looks like adults have to help kids figure kinship terms out: they're difficult to learn.

Dolls used by Alice Mitchell in Tanzania to elicit kinship terms from children during their natural play (2018).

What other projects are the excd lab currently working on?

Our Transmission project, investigating storytelling from a cultural transmission perspective, has just come to a close. We've a big paper in submission showing how we compared different kinds of social learning biases in the telling of a creation story. We designed a novel experimental paradigm that drew on the fact that as listeners we have "accent prejudice". We used this as a way to establish social status or "prestige" as one of the biases. And right now I'm working with other researchers to set up a new project to investigate these social biases in stories cross-culturally. Another project, led by Dr Sean Roberts now at Cardiff, is CHIELD (Roberts *et al*., 2020)- an exciting database that brings together hundreds of hypotheses about language evolution. Sean marshalled together an extensive team of contributors (some number of excd.lab members, including our undergrad researchers) to systematise causal hypotheses about how language evolves. Future work will continue my interests in natural resource management. I'm combining my personal love (plants and gardens) with research questions about the cultural uses of plants--what is often called ethnobotany. With colleagues at Reading and Norway, I have new projects that use phylogenetic methods to understand traditional medicinal uses of plants in Oceania and in the Viking world.

For you, what are the benefits and challenges of working in an interdisciplinary team?

To be honest, I wouldn't know any other way to work! I've never been satisfied with single explanatory frameworks for human behaviour, and while everything I do is rooted in the reality of evolutionary principles, I think dogmatism about disciplines constrains our ability to answer the big questions about culture. It's a personal benefit because there's always an interesting new perspective to take on a question: can we think about some cultural phenomena from different angles? And it helps alleviate the ego issues of being "wrong". I'm always wrong, because there's always some other part of the puzzle that another discipline can bring, but I've learned not to take that personally. It can be challenging to work with people across disciplines and to be patient while everyone learns each other's dialects, but there's also a real joy in being a translator for other people in that respect. The most challenging thing is never feeling that deep level of expertise in any one subject. I'm always learning (or struggling to catch up) on new methodological developments across biology, statistics, and linguistics, and keeping on top of the subject literature as well.

You have worked and studied in a variety of countries across the world. Have you found that the research environment has differed and if so, how?

The different countries were all at different phases of my career: undergrad and masters, PhD, postdoc, and faculty, so sometimes it's hard to disentangle differences from career experience. I worked in a Max Planck Institute in the Netherlands that was purely research-focused, and while it was amazing to have fantastic resources and research as my only responsibility, the pressure is intense, not all of it healthy. Universities are more balanced and allow people to use all of their skills in different ways at different stages, but that diversity of demands can also be challenging. One interesting reflection on national differences is that I think my New Zealand undergraduate experience was exceptionally high quality. I had amazing world-class lecturers (though I didn't realise it at the time, of course!). It combined the rigour and depth of UK subject-focused programmes with the flexibility of North American-style teaching, and allowed me to pursue a number of independent study projects. Funding for pure social science research is tricky in New Zealand, though: there's a small population base and a focus on applied research.

Fiona (front) and the excd (Evolution of Cross-Cultural Diversity) lab from the University of Bristol demonstrating the benefits of multidisciplinary teamwork to get out of an escape room.

How has academia changed since you did your PhD?

It's vastly more competitive, both due to the ever-increasing high standards and the sheer number of people with PhDs. But also a lot less tolerant of prejudice and status games, which is a good thing. It feels easier to speak out about cronyism, and bad behaviour. There's a way to go on all fronts, especially race and class privilege, but those conversations happen in a way that just didn't 20 years ago.

What is your best advice to an anthropology PhD student embarking on a career in academia?

In terms of a "career in academia": don't listen to people like me who got their jobs 10-20 years ago! We're the product of survivorship bias. The numbers are against you from the start, even if you're brilliant, even if you have all the passion in the world, even if your supervisor thinks "you'll be fine". Have a Plan A: Academia is Plan B. To keep things in perspective, think of your PhD as training to be a researcher and an expert. Society needs incisive anthropologists in so many walks of life, so grasp all the opportunities to broaden your skills and horizons. It's the delight of learning new things that leads you to even contemplate the weird, strange life of a PhD - holding on to that is key. Finally: be a good colleague. Be kind and generous, be interested, and be interesting.

Fiona (festively) working at her desk.

References:

Kirby, K.R., Gray, R. D., Greenhill, S. J., Jordan, F. M., Gomes-Ng, S., Bibiko, H. J., Blasi, D. E., Botero, C. A., Bowern, C., Ember, C. R., Leehr, D., Low, B. S., McCarter, J., Divale, W. and Gavin, M. C. (2016). D-PLACE: A Global Database of Cultural, Linguistic and Environmental Diversity. *PLoS ONE*, 11(7), e0158391. DOI: 10.1371/journal.pone.0158391.

Racz, P., Passmore, S., Sheard, C. and Jordan, F. M. (2019). Usage frequency and lexical class determine the evolution of kinship terms in Indo-European. *Royal Society Open Science,* 6191385. DOI: 10.1098/rsos.191385.

Racz, P., Passmore, S. and Jordan, F. M. (2019). Social practice and shared history, not social scale, structure cross-cultural complexity in kinship systems. In H. van Ditmarsch, P. Hendriks and R. Verbrugge (Eds.), *Topics in Cognitive Science. Special Issue: Lying in Login, Language and Cognition - The Cultural Evolution of Cognition*, 12(2), pp. 744-765. DOI: 10.1111/tops.12430.

Roberts, S., Killin, A., Deb, A., Sheard, C., Greenhill, S. J., Sinnemaki, K., Martin, J. S., Nolle, J., Berdicevskis, A., Humphreys-Balkwill, A., Little, H., Opie, K. C., Jacques, G., Bromham, L., Tints, P., Ross, R. M., Lee, S., Gasser, E., Calladine, J., Spike, M., Mann, S. F., Shcherebakova, O., Singer, R., Shuya, Z., Benitez-Burraco, A., Kliesch, C., Thomas-Colquhoun, E., Skirgard, H., Tamariz, M., Passmore, S., Pellard, T. and Jordan, F. (2020). CHIELD: The causal hypotheses in Evolutionary Linguistics Database. *Journal of Language Evolution*, 5(2), pp. 101-120. DOI: 10.1093/jole/lzaa001.

Part 5: Evolutionary Genetics

Professor Eske Willerslev[20]

Eske Willerslev is a world-renowned evolutionary geneticist, director of the University of Copenhagen's Lundbeck Foundation GeoGenetics Centre and holder of the Prince Philip Chair in Ecology and Evolution in the Department of Zoology at the University of Cambridge. His research spans a number of topics within evolutionary genetics, such as ancient DNA and environmental DNA. Much of his research also involves working with indigenous communities, leading to him being adopted into the Native American Crow tribe under the Indian name of "Well-Known Wolf". He has appeared in a number of films as an expert on human evolution, such as "First Peoples", "The Great Human Odyssey" etc, and has written a number of popular books.

What are your research interests and your particular area of expertise?

My speciality within human evolution is ancient genomics, sequencing and analysing the genomes of ancient individuals to understand our demographic history. I am particularly focused on modern human history; the history of contemporary *Homo sapiens*. The main aim of my research is therefore to understand how we, as modern humans, obtained our genetic diversity through processes like migration and adaptation. I also do a lot of work on infectious human diseases in regard to human history.

What was your path into evolutionary genetics? What originally drew you towards this discipline?

I was educated as a biologist at the University of Copenhagen in Denmark and I actually didn't enjoy my studies very much! There were only two modules that I really liked: evolutionary biology and human palaeontology. So, I guess biological sciences were the trajectory I initially took to get into evolutionary genetics, but it was certainly not a straightforward path to get there. During my Masters, I wanted to do DNA-based research to better understand the peopling of America -- that's what I was really interested in -- but nobody in Denmark at the time did this type of research as there were no ancient DNA laboratories. There was also no interest in my Department of Evolutionary Biology to expand into human evolution. So, I started working on extracting microbial DNA from ice cores, which was very interesting but not what I really wanted to do. It was when I first became a professor, and this happened quite early in my career, that I got the opportunity to finally pursue the area of research that I wanted and I've done so ever since!

I think that it is not necessarily unusual to see this in science. Quite often, when you are a student, you cannot always pursue exactly what you dream and are passionate about. Instead, you gradually work

[20] Lundbeck Foundation GeoGenetics Centre, University of Copenhagen, Denmark; Department of Zoology, University of Cambridge, UK; ewillerslev@sund.ku.dk

towards that goal. So that's what I did, every time I made choices that got me closer to this goal, even if they weren't exactly what I wanted to do at that moment.

What was your PhD experience like?

Well, I don't actually have a PhD! I started it but eventually I ended up submitting as a Doctor of Science thesis. Back when I wanted to do a PhD, there were very few around but I had been short-listed for a doctoral fellowship at my University - I was actually first on the list for this place. However, my supervisor ended up choosing another student instead of me! Of course, I was very upset at the time as I felt it was unreasonable, but my supervisor had decided on that other student because, ultimately, she was much more interested in the topic. But, I got so annoyed about not getting the fellowship that I decided I would submit my work as a Doctor of Science thesis! This is actually a bigger piece of research, where you have to provide more papers and, because I had worked really hard, I did end up having enough to submit in this format. You normally do a Doctor of Science towards the end of your career, so a lot of people thought it was very odd that I did this so early and got upset, my supervisor included, as he hadn't got a Doctor of Science... But it turned out to be a clever move in the sense that I already had a blueprint that showed I was capable of becoming a full professor, and so I achieved this just one and a half years after I did my thesis and defence.

What projects are you currently working on?

I'm working on several projects currently, but my main focus at the moment is to understand the origins of disease susceptibility -- the genetic variants associated with disease risk in humans. For example, I'm trying to understand why some people have an increased risk of mental disorders or diabetes, as well as other diseases. To look at the origins of these problems, we have to go back into history and study genomes from the past. Therefore, currently my research aims to try and uncover why we face these pathological challenges that are so prevalent today. Where did they come from? Why did they evolve? These kinds of questions.

What project are you most proud of?

I'm definitely most proud of the third or fourth paper from my career, the one that established the field of environmental DNA. This is where you take environmental samples, such as soil or water from the ocean or lakes and sequence the DNA in these samples. Through doing this, you can find out what animals and plants were and are living in certain places despite not having any macro-fossil evidence. This paper was published in Science in 2003 and, even though it's not my most cited paper, I am very proud of it because I believe it was really original at the time (Willerslev *et al*., 2003). Even in incidences where I was the first to do something, like sequence the first ancient genome (Rasmussen *et al*., 2010), these were natural progressions -- someone else would have made these next steps a few years later if I had not. This paper was not like that, as it was not only one step or two steps ahead, but multiple. It took 10 years before anyone trusted this research and I actually had a few problems getting subsequent papers published because of it! My supervisor thought it was the most stupid idea he had ever heard!

Eske collecting eDNA samples in Northern Greenland (2006)

Now, environmental DNA is a field that is widespread in genetics, and a lot of palaeontologists and ecologists rely on its fundamental principles, that DNA from higher organisms is present in the environment even if we can't see it. This was a completely new way of thinking that had not been seen before -- understanding that we might be walking around on DNA from the present and the past, be it from a leaf that has fallen from a tree and subsequently degraded or a dog that has left faeces on the street that has since washed away. Following this idea, I produced this paper which became the foundation of environmental DNA, and also made me more widely known in the scientific community. So yes, I'm very proud of it.

What have been your favourite and most memorable experiences of your career?

I think it has to be engaging with the indigenous communities. A lot of my research on ancient human remains has involved connecting these skeletons with their traditional owners, both in Australia and the Americas. For me, it's some of the most interesting experiences I've had in relation to my work, because not only has it given me perspectives on why many of these communities are reluctant to participate in scientific research but it has also changed my own way of looking at life and indeed the world around us. I am very grateful to have had these opportunities.

Eske visiting the Northern Cheyenne Reserve in Montana, talking to members of the Cheyenne and Crow Native American Tribes

What do you think has been the most revolutionary discovery in human evolution studies over the last 5 years?

This is tricky - good question! I think it's the fact that you can obtain pathogens from human skeletons without any physical or morphological evidence for disease. This was actually a paper that we did back in 2015 in Cell, where we found evidence for a plague epidemic at least 3,000 years before any other recorded epidemics (Rasmussen *et al*., 2015). We had known that you could extract pathogens out of skeletons that have been infected and show physical signs of infection, but we also realised was that you also can obtain pathogens out of large number of skeletons showing no signs of infection; this is a real game-changer with regard to the possibilities to understanding human pathogen evolution, how they spread etc.

I think another one would be the work that has been primarily done by my colleague, Enrico Cappellini, who has found a way to sequence enamel proteins to investigate evolutionary questions about the deep past -- now known as the field of proteomics. I've been on some of these papers, but others have primarily been driving this new wave of research. The first foundational paper was published just this year and allowed us to investigate the evolutionary relationship between *Homo antecessor* and other hominin species (Welker *et al*., 2020). I think proteomics has powerful potential for understanding hominin evolution way further back in time than we are currently able to do with aDNA.

References:

Rasmussen, M., Li, Y., Lindgreen, S., Pedersen, J. S., Albrechtsen, A., Moltke, I., Metspalu, M., Metspalu, E., Kivisild, T., Gupta, R., Bartalan, M., Nielsen, K., Gilbert, M. T. P., Wang, Y., Raghavan, M., Campos, P. F., Kamp, H. M., Wilson, A. S., Gledhill, A., Tridico, S., Bunce, M., Lorenzen, E. D., Binladen, J., Guo, X., Zhao, J., Zhang, J., Li, Z., Chen, M., Orlando, L., Kristiansen, K., Bak, M., Tommerup N., Bendixen, C., Pierre, T. L., Gronnow, B., Meldgaard, M., Andreasen, C., Fedorova, S. A., Osipova, L. P., Higham, T. F. G., Ramsey, C. B., Hansen, T. V. O., Nielsen, F. C., Crawford, M. H., Brunak, S., Sicheritz-Ponten, T., Villems, R., Nielsen, R., Krogh, A., Wang, J. and Willerslev, E. (2010). Ancient human genome sequence of an extinct Palaeo-Eskimo. *Nature,* 463, pp. 757–762. DOI: 10.1038/nature08835.

Rasmussen, S., Allentoft, M. E., Nielsen, K., Orlando, L., Sikora, M., Sjogren, K. G., Pedersen, A. G., Schubert, M., Van Dam, A., Kapel, C. M. O., Nielsen, H. B., Brunak, S., Avetisyan, P., Epimakhov, A., Khalyapin, M. V., Gnuni, A., Kriiska, A., Lasak, I., Metspalu, M., Moiseyev, V., Gromov, A., Pokutta, D., Saag, L., Varul, L., Yepiskoposyan, L., Sicheritz-Ponten, T., Foley, R. A., Mirazon Lahr, M., Nielsen, R., Kristiansen, K. and Willerslev, E. (2015). Early divergent strains of *Yersinia pestis* in Eurasia 5,000 years ago. *Cell*, 163(3), pp. P571-582. DOI: 10.1016/j.cell.2015.10.009.

Willerslev, E., Hansen, A. J., Binladen, J., Brand, T. B., Gilbert, T. P., Shapiro, B., Bunce, M., Wiuf, C., Gilichinsky, D. A. and Cooper, A. (2003). Diverse Plant and Animal Genetic Records from Holocene and Pleistocene Sediments. *Science*, 300(5620), pp. 791–795. DOI: 10.1126/science.1084114.

Welker, F., Ramos-Madrigal, J., Gutenbrunner, P., Mackie, M., Tiwary, S., Jersie-Christensen, R. R., Chiva, C., Dickinson, M. R., Kuhlwilm, M., de Manuel, M., Gelabert, P., Martinon-Torres, M., Margvelashvili, A., Arsuaga, J. L., Carbonell, E., Marques-Bonet, T., Penkman, K., Sabido, E., Cox, J., Olsen, J. V., Lordkipanidze, E., Racimo, F., Lalueza-Fox, C., Bermudez de Castro, J. M., Willerslev, E. and Cappellini, E. (2020). The dental proteome of *Homo antecessor*. *Nature,* 580, pp. 235–238. DOI: 10.1038/s41586-020-2153-8.

Dr Pontus Skoglund[21]

Photo by the Francis Crick Institute.

Pontus Skoglund is an evolutionary geneticist at the Francis Crick Institute. Pontus is the group leader of the Ancient Genomics Laboratory, which applies and develops ancient genomics to understand past human diversity. Originally from Sweden, he obtained his PhD from Uppsala University in 2013, and thereafter did his postdoctoral research in David Reich's laboratory at Harvard Medical School's Department of Genetics. His research covers a range of topics within evolutionary genetics, such as the link between population migrations and the global transition to agriculture, archaic gene flow, early human evolution in Africa, the peopling of the Americas, and the origin of domestic dogs.

What are your research interests and your particular area of expertise?

I work on ancient genomics, specializing in making sense of ancient DNA data, and the issues that come with it, to learn about genomic history, adaptation, and the human past.

What originally drew you towards evolutionary genetics?

As a kid, I probably visited the Swedish Museum of Natural history in Stockholm over 20 times, but I can't say that I always knew what I wanted to do. I was always interested in evolution because it relates to who us humans are, but also has a few almost-mechanistic forces (for example mutation) that makes it reminiscent of another topic I really liked in school: physics. So I was very drawn to evolutionary genetics but also conflicted about its historical legacy, which includes eugenics. There was a vibe of biological determinism associated with genetics that was uncomfortable, but it seemed genuinely interesting how we can understand ourselves as the product of both evolution/biology and our social surroundings. Today I think that the more people that enter fields with historical legacies like that, the better. Evolutionary genetics is very exciting in that it crosses perspectives: the past and the future, paleoanthropology and biomedicine.

What was your PhD topic? Where did you complete your PhD and who was your supervisor?

I started my PhD with Mattias Jakobsson at Uppsala University in 2009, and finished in 2013. I had done an MSc project on ancient DNA with Anders Götherström before that and was very attracted to the temporal data that ancient DNA promised. In 2009, ancient DNA was almost laughed at, and seen as a niche pursuit among human geneticists. But for those who looked beyond that there was already evidence that genomic sequencing was possible in principle. In any case, I thought that it would be more important to learn to work with large-scale genomic data for that eventual future, and thought it could be a great opportunity to work with Mattias, and it was. When I started, I didn't really have a project, just to study human genomes, probably from the present-day, to understand history.

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[21] The Francis Crick Institute, London, UK; pontus.skoglund@gmail.com

What were the findings from your PhD?

What ended up being the central project was that my thesis co-advisor Anders Götherström and his group had for long been interested in the question of whether farming practice spread through Europe by migrating human groups or as a viral idea, 'memes or genes'. In Scandinavia, people practicing farming and foraging coexisted close together around 5,000 years ago. At the time, there were no ancient human genomes and it seemed that ancient genomes were for huge projects like the Saqqaq genome (Rasmussen *et al*., 2010) and the Neandertal genome (Green *et al*., 2010), both published later in 2010. How could we use this clearly amazing thing that was next-generation sequencing of ancient DNA to do 'proper' human statistical genetics, not just of mitochondrial DNA? It seemed nearly impossible to deal with the contamination issue, there was just no way to know nuclear DNA was real unless a high-quality genome could be obtained, or the genome was of a rare ancestry that could not be from contaminating people. Nevertheless, I suggested trying out the direct sequencing approach that we had worked on during my MSc thesis on Anders' material (Malmstrom *et al*., 2009), as a direct test of whether the two cultural groups reflected different populations.

Sequencing complete genomes would cost a fortune, since the DNA is so poorly preserved, but maybe even just about 1% of random sequences scattered across the genome of each individual could be enough. Since we didn't have to directly compare each ancient individual to the others, we could use the medical databases of living people's genomes to connect the dots, and Mattias was an expert in that type of data. The results were quite astonishing to us, prehistoric hunter-gatherers in Scandinavia did not match the genetic makeup of any populations in Europe today, but they were most similar to people in the northern parts of Europe (Skoglund *et al*., 2012). Farming-associated individuals shared close ancestry with present-day people in the Mediterranean. The data thus suggested Neolithic groups spread across the European continent without much influence from the local people. What I was most excited about was a solution to the contamination problem: I isolated the sequences that showed clear signs of ancient DNA degradation computationally and showed that the results were the same, which was a new approach that is now common (Skoglund *et al.,* 2014). Then, I ended up spending the rest of my PhD working on improving these methods for dealing with modern contamination, and using the analysis approaches on collaborative projects with others, on questions ranging from present-day variation in southern Africa with Mattias and Carina Schlebusch (Schlebusch *et al*., 2012), to remove contamination from a Neandertal sequenced by Johannes Krause and Svante Pääbo (Skoglund *et al.,* 2014), and to help on Eske Willerslev's projects on genomes from the Americas (Raghavan *et al.,* 2014; Rasmussen *et al.,* 2014), which were all very exciting too.

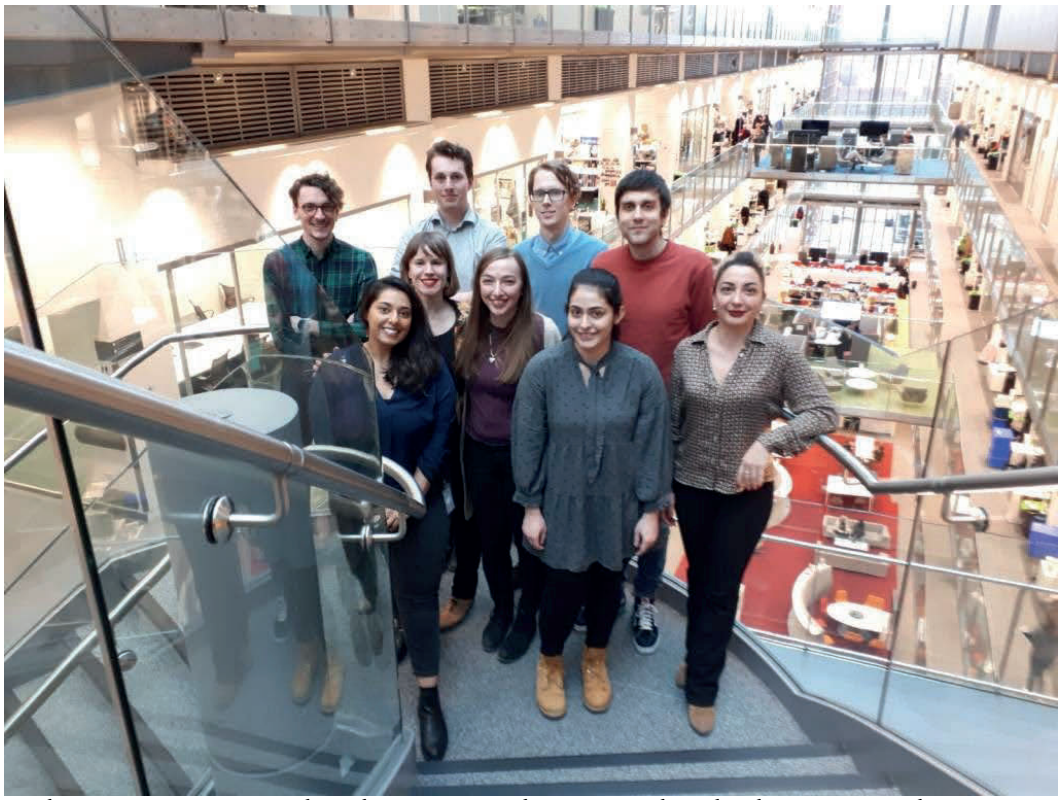
After your PhD, where have you worked? Where has been your favourite place to work?

After my PhD I worked as a postdoc in David Reich's lab at Harvard University which was a wonderful and highly rewarding experience, and then I moved to my current work at the Francis Crick Institute. As a place and building, my favourite would be the Crick, it is very inspiring and a great place to be a part of the UK archaeo-scientific community.

What current projects are you working on at the Francis Crick Institute? Where do you hope these go in the future?

One of our main interests is to study the past few thousand years of a region in some detail with full genomes: Britain. The reason is not only the detailed archaeological record and community here, but also that the #1 resource in medical genetics is the UK biobank of half a million people. We are hoping to understand genomic history in detail, but also bring ancient genomics and medical genetics together by learning about the evolution of diseases and traits over all the complexities of history. We are also

interested in working on the frontier to obtain ancient genome and proteome information from times and places where it is very hard to get it to understand deeper human evolution.



The Ancient Genomics Lab at the Francis Crick Institute. Photo by the Francis Crick Institute.

As a geneticist, do you approach questions about the past differently to an archaeologist or anthropologist?

I think most similarly to paleoanthropologists, as we are often studying patterns that occur on the time scale of population history, hundreds or thousands of years. I have been in constant interaction with archaeologists and anthropologists since the beginning of my PhD. It is always very exciting, and face-to-face it is always pleasant to talk with the most genetics-sceptical of archaeologists. A lot of the perceived differences are communicative, but there are also differences in perspectives. To many, and to me as I considered starting in the field, genetics also has a vibe of the old politically-driven race sciences. It is our responsibility to overcome it. A person who was an early role model for me in this was Carina Schlebusch in Uppsala, in how she approached genetic studies of the past in southern Africa.

Is ancestry the most important thing to understand about the human past? Probably not, but all archaeologists and anthropologists I know agree that it would be an amazing information resource to know the parents of everyone who ever lived, the grand weave of human ancestry. Ancient DNA is the closest we can get to that.

Do you work on other projects outside of human evolution studies?

I have been interested in the origin of dogs for a long time, since I was an MSc student. When and where it happened is unknown, to me it is one of the major remaining 'known mysteries' of the Upper Paleolithic that should be possible to solve with ancient DNA. We have an ongoing project in the lab on

ancient dog and wolf genomes and are hoping to understand the original domestication process, how wolves and dogs evolved over the past 100,000 years, and how tracking dog DNA can teach us new things about human history.

What advice would you give to a student interested in your field of research?

Setbacks and rejections are inevitable, and though it may seem so, almost no one is born with a thick skin. As Paul Nurse, our director here at the Crick, says, most hypotheses are wrong so research is about failing again and again, and university doesn't really prepare you for that. I would also say that reading the best papers in your field is like cardio to a researcher, and the best way to lead you into developing the right technical skills and identifying interesting questions. Be sincere in your research, be proud of the scientific ethos of finding the truth. Finally I would invest some time in quantitative and computational skills, useful in any discipline related to human evolution.

What do you think has been the most revolutionary discovery in your field over the last 5 years?

For the readers here who may be most interested in deeper human evolution, I would say the finding of particular individuals such as the Oase 1 individual from Romania that has a very recent Neanderthal ancestor (Fu *et al.,* 2015), and the archaic human person from Denisova cave that has both a Neanderthal and a Denisovan parent (Slon *et al.,* 2018). Until these individual finds, admixture between evolutionarily distant human populations has been somewhat of a statistical abstraction, with many unknowns. While these finds confirmed processes that were in principle already known by statistical analyses of other genomes, I think they provide stable data points that are rare in a field where it can be difficult for many to distinguish between reliable and exaggerated statistical claims.

If you were not an evolutionary geneticist, what would you be?

Within research I would have a hard time picking another topic. I would have enjoyed studying computer science more closely, and perhaps worked on something more directly oriented towards the human future rather than the past.

References:

Fu, Q., Hajdinjak, M., Moldovan, O. T., Constantin, S., Mallick, S., Skoglund, P., Patterson, N., Rohland, N., Lazaridis, I., Nickel, B., Viola, B., Prufer, K., Meyer, M., Kelso, J., Reich, D. and Paabo, S. (2015). An early modern human from Romania with a recent Neanderthal ancestor. *Nature*, 524(7564), pp. 216-19 DOI: 10.1038/nature14558.

Green, R. E., Krause, K., Briggs, A. W., Maricic, T., Stenzel, U., Kircher, M., Patterson, N., Li, H., Zhai, W., Fritz, M. H. Y., Hansen, N. F., Durand, E. Y., Malaspinas, A. S., Jensen, J. D., Marques-Bonet, T., Alkan, C., Prufer, K., Meyer, M., Burbano, H. A., Good, J. M., Schultz, R., Aximu-Petri, A., Butthof, A., Hober, B., Hoffner, B., Siegemund, M., Weihmann, A., Nusbaum, C., Lander, E. S., Russ, C., Novod, N., Affourtit, J., Egholm, M., Verna, C., Rudan, P., Brajkovic, D., Kucan, Z., Gusic, I., Doronichev, V. B., Golovanova, L. V., Lalueza-Fox, C., de le Rasilla, M., Forteez, J., Rosas, A., Schmitz, R. W., Johnson, P. L. F., Eichler, E. E., Falush, D., Birney, E., Mullikin, J. C., Slatkin, M., Nielsen, R., Kelso, J., Lachmann, M., Reich, D. and Paabo, S. (2010). A draft sequence of the Neandertal Genome. *Science,* 328(5979), pp.710-722. DOI: 10.1126/science.1188021.

Malmstrom, H., Gilbert, M. T. P., Thomas, M. G., Brandstrom, M., Stora, J., Molnar, P., Andersen, P. K., Bendixen, C., Holmlund, G., Gotherstrom, A. and Willerslev, E. (2009). Ancient DNA reveals lack of continuity between Neolithic hunter-gatherers and contemporary Scandinavians. *Current Biology*, 19(20), pp. 1758-1762. DOI: 10.1016/j.cub.2009.09.017.

Raghavan, M., Skoguland, P., Graf, K. E., Metspalu, M., Albrechtsen, A., Moltke, I., Rasmussen, S., Stafford, T. W., Orland, L., Metspalu, E., Karmin, M., Tambets, K., Rootsi, S., Magi, R., Campos, P. F., Balanovska, E., Balanovsky, O., Khusnutdinova, E., Litvinov, S., Osipova, L. P., Fedorova, S. A., Voevoda, M. I., DeGiorgio, M., Sicheritz-Ponten, T., Brunuk, S., Demeshchenko, S., Kivisild, T., Villems, R., Nielsen, R,. Jakobsson, M. and Willerslev, E. (2014). Upper Palaeolithic Siberian genome reveals dual ancestry of Native Americans. *Nature,* 505, pp. 87–91. DOI: 10.1038/nature12736.

Rasmussen, M., Li, Y., Lindgreen, S., Pedersen, J. S., Albrechtsen, A., Moltke, I., Metspalu, M., Metspalu, E., Kivisild, T., Gupta, R., Bartalan, M., Nielsen, K., Gilbert, M. T. P., Wang, Y., Raghavan, M., Campos, P. F., Kamp, H. M., Wilson, A. S., Gledhill, A., Tridico, S., Bunce, M., Lorenzen, E. D., Binladen, J., Guo, X., Zhao, J., Zhang, J., Li, Z., Chen, M., Orlando, L., Kristiansen, K., Bak, M., Tommerup N., Bendixen, C., Pierre, T. L., Gronnow, B., Meldgaard, M., Andreasen, C., Fedorova, S. A., Osipova, L. P., Higham, T. F. G., Ramsey, C. B., Hansen, T. V. O., Nielsen, F. C., Crawford, M. H., Brunak, S., Sicheritz-Ponten, T., Villems, R., Nielsen, R., Krogh, A., Wang, J. and Willerslev, E. (2010). Ancient human genome sequence of an extinct Palaeo-Eskimo. *Nature,* 463, pp. 757–762. DOI: 10.1038/nature08835.

Rasmussen, M., Anzick, S. L., Waters, M. R., Skoglund, P., DeGiorgio, M., Stafford Jr, T. W., Rasmussen, S., Moltke, I., Alberchtsen, A., Doyle, S. M., Poznik, G. D., Gudmundsdottir, V., Yadav, R., Malaspinas, A. S., Stockton, S., White, V., Allentoft, M. E., Cornejo, O. E., Tambets, K., Eriksson, A., Heintzman, P. D., Karmin, M., Korneliussen, T. S., Meltzer, D. J., Pierre, T. L., Stenderup, J., Saag, L., Warmuth, V., Lopes, M. C., Malhi, R. S., Brunak, S., Sicheritz-Ponten, T., Barnes, I., Collins, M., Orlando, L., Balloux, F., Manica, A., Gupta, R., Metspalu, M., Bustamante, C. D., Jakobsson, M., Nielsen, R. and Willerslev, E. (2014). The genome of a late Pleistocene human from a Clovis burial site in western Montana. *Nature*, 506(7487), pp. 225-229. DOI: 10.1038/nature13025.

Schlebusch, C. M., Skoglund, P., Sjodin, P., Gattepaille, L. M., Hernandez, D., Jay, F., Li, S., De Jongh, M., Singleton, A., Blum, M. G. B., Soodyall, H. and Jakobsson, M. (2012). Genomic variation in seven Khoe-San groups reveals adaptation and complex African history. *Science*, 338(6105), pp. 374-379. DOI: 10.1126/science.1227721.

Skoglund, P., Malmstrom, H., Raghavan, M., Stora, J., Hall, P., Willerslev, E., Gilber, M. T. P., Gotherstrom, A. and Jakobsson, M. (2012). Origins and genetic legacy of Neolithic farmers and hunter-gatherers in Europe. *Science,* 336(6080), pp.466-469. DOI: 10.1126/science.1216304.

Skoglund, P., Northoff, B. H., Shunkov, M. V., Derevianko, A. P., Paabo, S., Krause, J. and Jakobsson, M. (2014). Separating endogenous ancient DNA from modern day contamination in a Siberian Neanderthal. *Proceedings of the National Academy of Science*, 111(6), pp. 229-2234. DOI: 10.1073/pnas.1318934111.

Slon, V., Mafessoni, F., Vernot, B., de Filippo, C., Grote, S., Viola, B., Hajdinjak, M., Peyrégne, S., Nagel, S., Brown, S., Douka, K., Higham, T., Kozlikin, M. B., Skunkov, M. V., Derevianko, A. P., Kelso, J., Meyer, M., Prufer, K., and Paabo, S. (2018). The genome of the offspring of a Neanderthal mother and a Denisovan father. *Nature,* 561, pp. 113–116. DOI: 10.1038/s41586-018-0455-x.